POPULAR SCIENCE MONTHLY

APR. 1947
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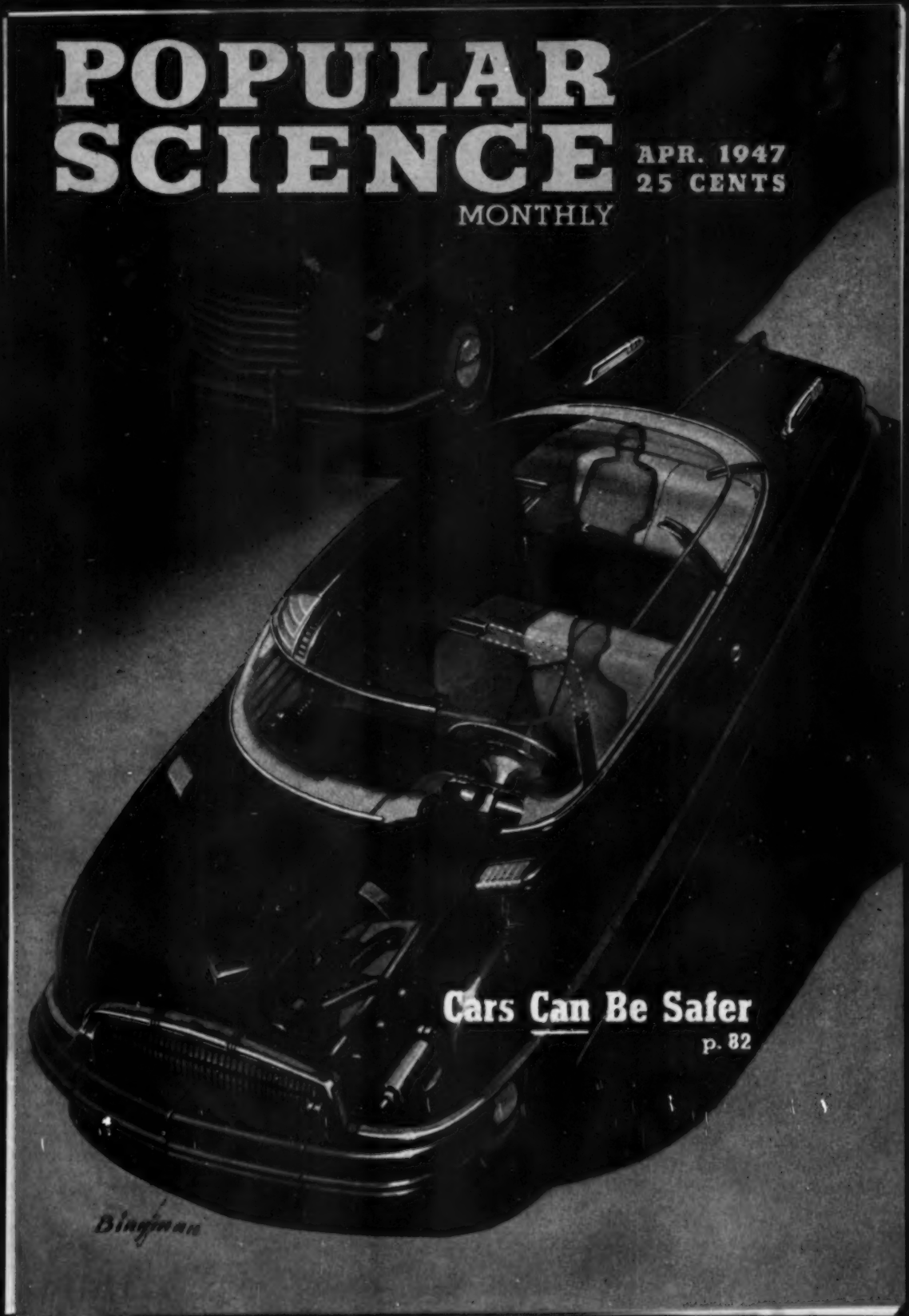

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p. 82

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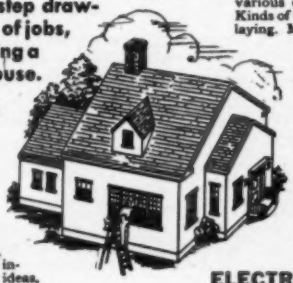

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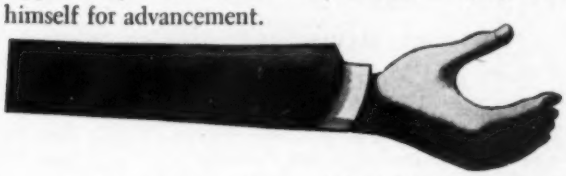

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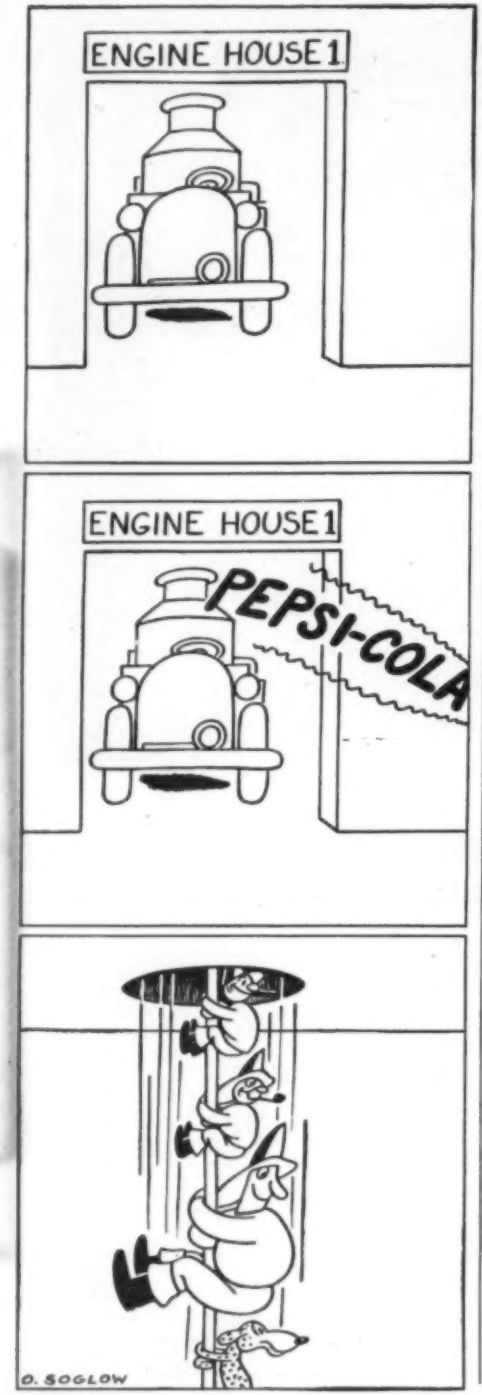

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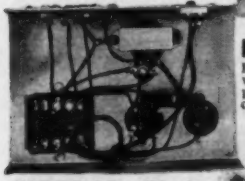

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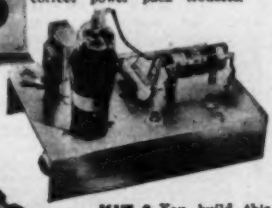

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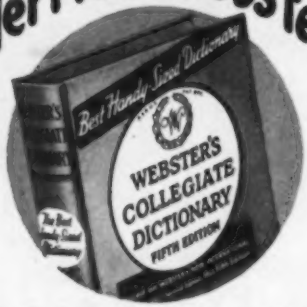

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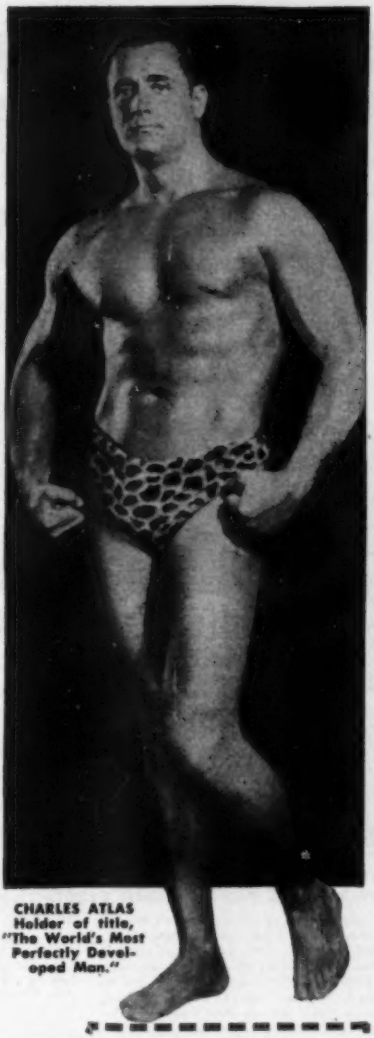

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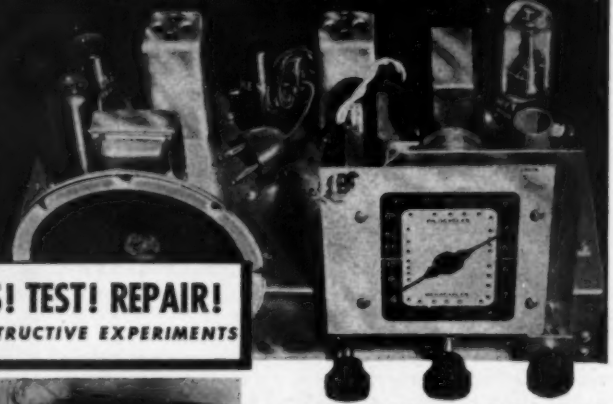

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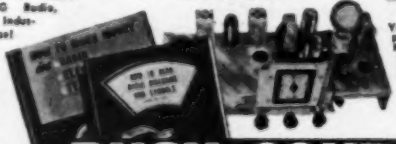

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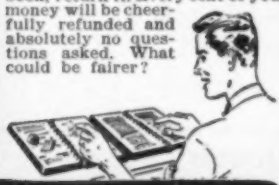

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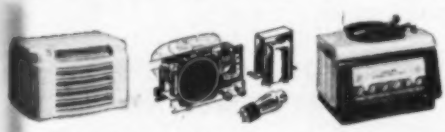

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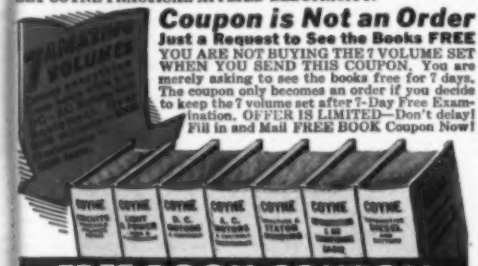

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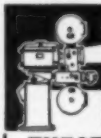

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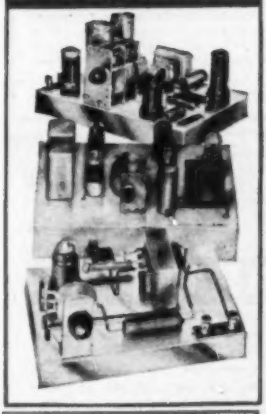

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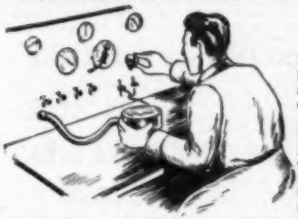

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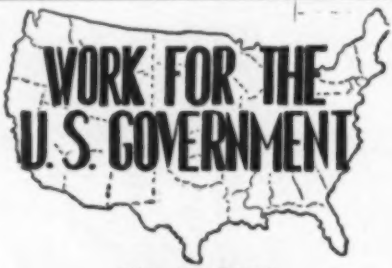

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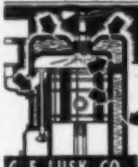

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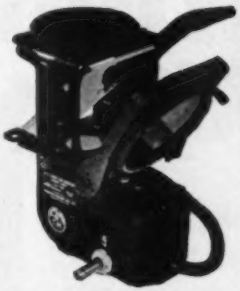

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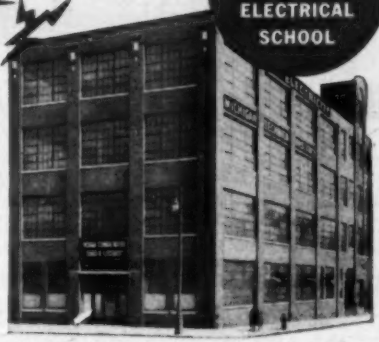

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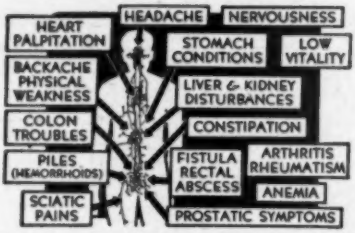

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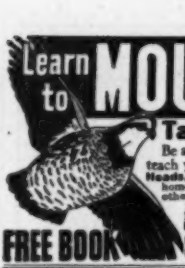

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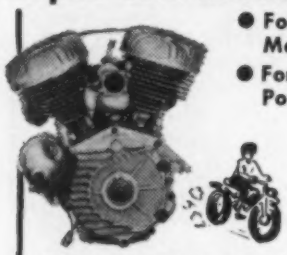

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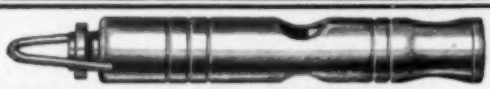

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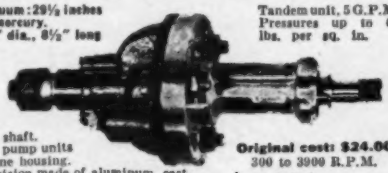

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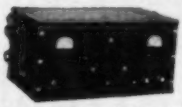

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DUAL mufflers for B-8's. Finest obtainable. Beautiful deep tone. Complete with necessary welded pipes, two mufflers, brackets. E-Z installation. $20.00. Clymer, Dept. B42, W. Pico, Los Angeles 6, Calif.

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DUALTONE Chrystalline packed mufflers. Sing.e or twin mufflers for all cars. Duals priced complete V8's $23.00. Six cylinders $33.00. Eight cylinders $36.00. Large chromed tailpipe extensions $3.30. Polished carburetor velocity stacks $1.30. Chromed Station Wagon stacks $15.00. Request catalogue. Dualtone Mufflers, 2636B India Street, San Diego 1, California.

HOT-rod and fast stock car equipment. List 25c 1½ h.p. from older Briggs and Strattons. Instructions $1.00. Alden Motors, Oakland City, Indiana.

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"USED Car Handbook." Dealers' tricks exposed, buying tips, previous owner clues, simple comprehensive tests. Postpaid $1.00. Truvalu, Box 723-C, Arcadia, Calif.

BUILD speedy Midget track racer from castoff parts! Plans, specifications, construction information, $1.00. Motor Supply, Box CS-1682, Toledo, Ohio.

SPEED & Mileage manual—Easily obtain greater speed, mileage, racing performance from any automobile! Includes simplified methods, speed tuning, gas saving secrets. Instructions on building economizers, speed equipment, dual carburetors, mufflers, superchargers, racing fuels, fast conversions, $1.98. Almquist Engineering, 447 (R) 64th Street, Brooklyn 20.

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MAKE your Ford fast! Complete details, photographs. How to construct 120 mph Hotrod. $1 postpaid. California Bill, Eaglerock Box L-2, Los Angeles 41, Calif.

SEE our ad under Motorcycles for midget racer bargains. Midget Motors Directory, Athens, Ohio.

13 AUTO SUPPLIES & EQUIPMENT

HAVING Car Trouble? New, Used, guaranteed auto, truck parts save money. Transmission specialist. Describe needs; immediate reply. Victory, 2930½ No. Western, Chicago 18.

AUTO parts for all autos and trucks. Trans. motors, differentials, fenders, carburetors. Also Body Parts. Security Auto and Truck Parts, 1941 BP Eddy, Chicago 13.

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GRILLES for most all cars. Meyers Auto Parts, 820 Dryades, New Orleans, La.

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MUFFLER manual. Convert easily to Hollywood, Laguna, Westwood, duals, etc. Includes construction details, regulations, diagrams. Postpaid $1. Mellotone, Box 723C, Arcadia, Calif.

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SCHRADER service station gauge 10 to 160 lbs. $1.75. E. Weill, 1650 East 38 St., Brooklyn, N. Y.

14 AUTO TRAILERS

BUILD your own Trailer! Save Money! Have every feature you want! Plans for House, Sport, Camp and Utility trailers. Catalog describing 9 models 10c. (15c in Canada and overseas). Jim Dandy, Box 125-B, Wausau, Wisconsin.

TRAILER Travel Monthly Magazine. Plant City 5, Fla. Twelve issues $1. Sample 15c.

91 MOTORCYCLES, BICYCLES, SUPPLIES

FACTORY built Motorscooter $45, 1946 Midget Car $65, Tires $1.00! Send 25c for bargain catalog packed with money saving buys in motorscooters, motorbikes, midget cars, motors, wheels, tires and parts. Gail and Company, 538 Erie, Toledo, Ohio.

LARGE stock Indian parts. Expert motor rebuilding. New and rebuilt Chief Motorcycle, motors only. Indian Motorcycle Sales, Kansas City 1, Mo.

WHEELS, Tires, Tubes for Motor Scooters, Midget Cars, Wheelbarrows, and Industrial equipment. All sizes. Bicycle Parts, accessories. Largest stock in United States. Send dime for list. Cycle Transport Company, 1241 S. Michigan Ave., Dept. C, Chicago 5, Illinois.

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WHEELS, Steel Disc rubber-tired for toys, wagons, scooters, etc. Sizes 5", 6", 7", 8", 10" available. United Wheels Mfg. Co., 11727 La Fayette Avenue, Chicago 28, Illinois.

MOTOR Scooters, bicycle engines, 120 miles gallon. Dime for catalog. Clymer, Desk B45, 2125 W. Pico, Los Angeles 6, Cal.

CLYMER'S Motorcycle books. Speedway Motorcycle Racing, $2.00. Motorcycle Speedway Annual, $1.00. How to Manage Motorcycles, $1.50. Motorcycling Manual, $2.00. How to Obtain Speed, $1.50. Motor Scooter Plans, $2.00. Books on Ariel, BSA, Norton, Triumph, Villiers engines, $1.50 each. English Motorcycle Magazine, 50c. All postpaid. See our ad automobile section. Catalog free. Clymer, Dept. B44, W. Pico, Los Angeles 6, Calif.

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15 AVIATION

PROPELLERS — Illustrated literature, correct type, sizes for ice-snow sleds, boats. Airliner 3 blade, also 2 blade. Build your own motor, aircool diagrams 50c. Standard Aerocraft, Ft. Worth, Texas.

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49 ELECTRICAL SUPPLIES & EQUIPMENT

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MOTORS, 110 volt, 60 cycle, 1/6 H.P. $18.50 1/12 H.P. $9.00. Sump pumps $34.50. 16" exhaust fans $38.50. 20" counter fans $28.50. Vic's Electric, 208 Niagara, Buffalo, N. Y.

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17 BATTERIES, GENERATORS, ETC.

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BIG packets, all different stamps, 10c each (11 for $1) 30 Asia; 30 Belgium; 50 British Colonies; 50 Denmark; 50 France; 40 Hungary; 30 India; 50 Italy; 25 Norway; 25 Portugal; 30 South America; 25 Spain; 30 Sweden; 25 Uruguay. Longacre Shop, 100-C West 42nd., New York City 18.

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107A POTTERY & CERAMICS

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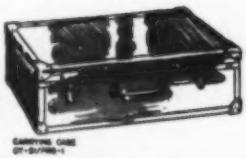

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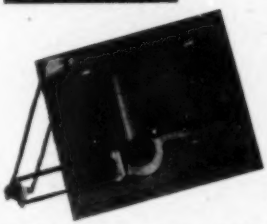

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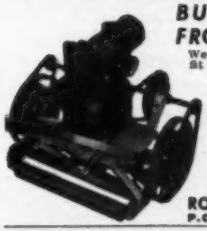

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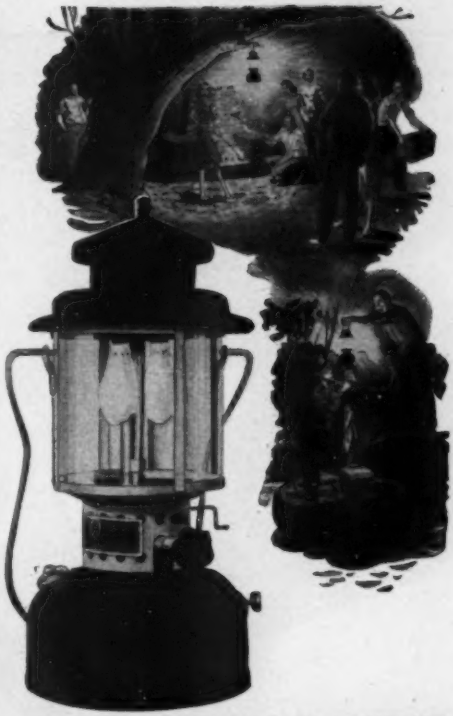

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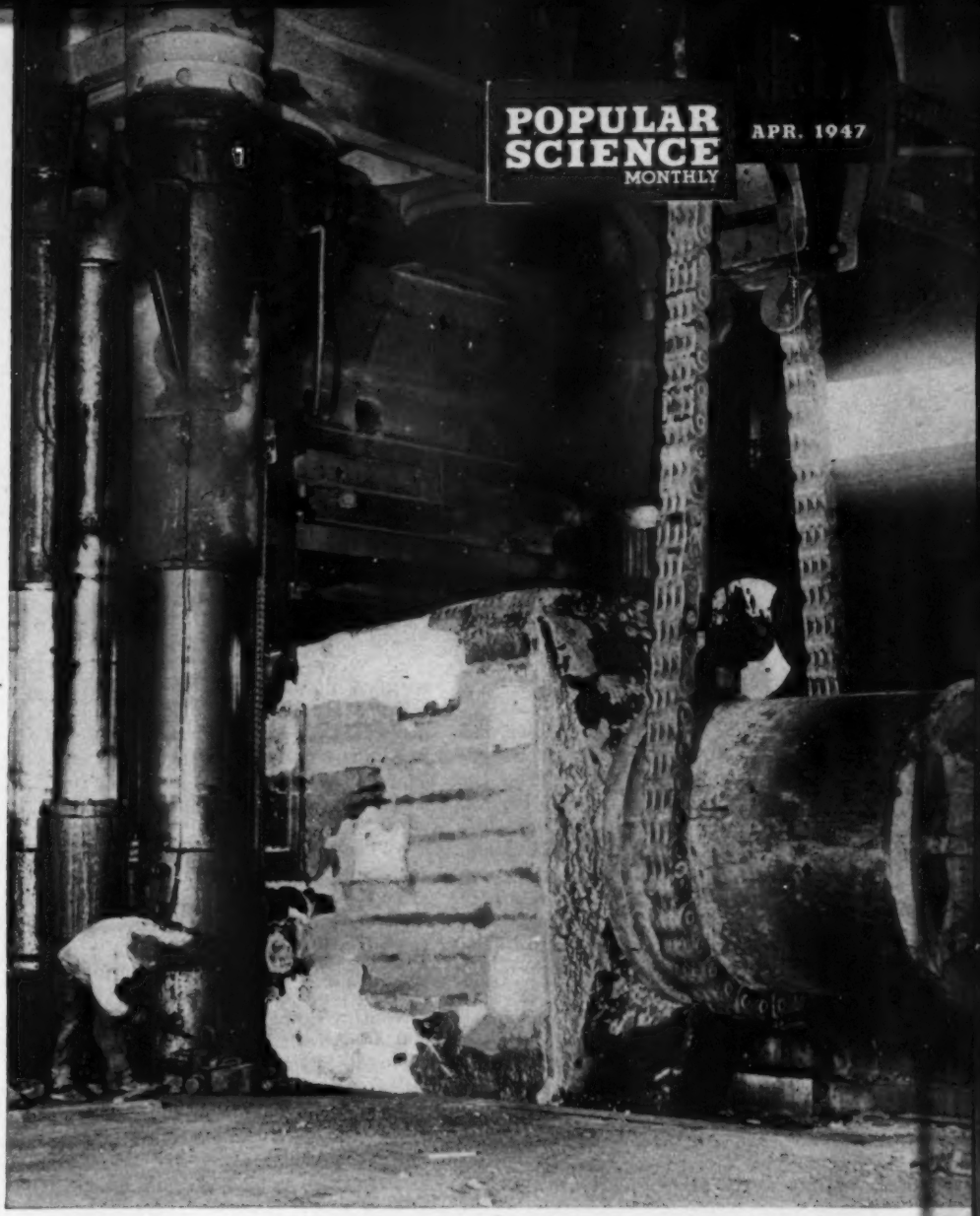

Shaping an Atom Smasher

The jaws of a 7,000-ton Carnegie-Illinois forging press are squeezing this huge steel ingot into a pole piece of an 1,100-ton magnet for the second largest cyclotron in the U. S. Designed to produce particles of more than 200,000,000 electron volts, the atom smasher is being built at the University of Rochester as part of the Navy's radiation research program.

Automobiles still kill tens of thousands; they'll go on doing it until you and the rest of the buying public are willing to pay the price of safety.

Cars Can Be Safer

By DEVON FRANCIS

YOU have left the outskirts of town and are rolling on the highway, the speedometer comfortably short of 50. Your car is fresh-tuned for spring; tires are newish, brakes sharp; there is not a squeak or rattle to spoil the purr of the engine. Suddenly, a car comes toward you. It is not going very fast. It veers slightly. It rolls with agonizing slowness across the freshly painted white line, toward you . . . toward you. You jam on the brakes, but you are still doing 15 or 20 when it hits you. . . .

You are washing the car in your driveway. The grade of the driveway is slight, barely enough to make an egg roll. Your kid is playing in the front seat. You bend down to wring out the chamois, look up and realize the car is moving. You scrabble for the doors, but the windows are closed. By the time you get a door opened, the car—moving all of five miles an hour—has smashed into the corner of the garage. The bumper breaks. The child screams. The doctor bill for hurts suffered by the youngster when he was pitched into assorted knobs on the instrument panel is $10. The repair bill on your radiator is $40.

You may be the best driver on the insurance companies' records, but if you don't carry the scars of an accident as you read this, you can thank your good luck as well as your skill.

For in the last 25 years—during which every reader of this magazine has been driving or riding in a motor vehicle—some 500,000 Americans have been shoveled under tombstones because they were involved in automobile accidents. Uncounted millions have been maimed and bruised. Additional millions have had so many close shaves on the highway that they are calloused to the statistics of daily disaster.

This month starts the annual American open season on motorists and pedestrians

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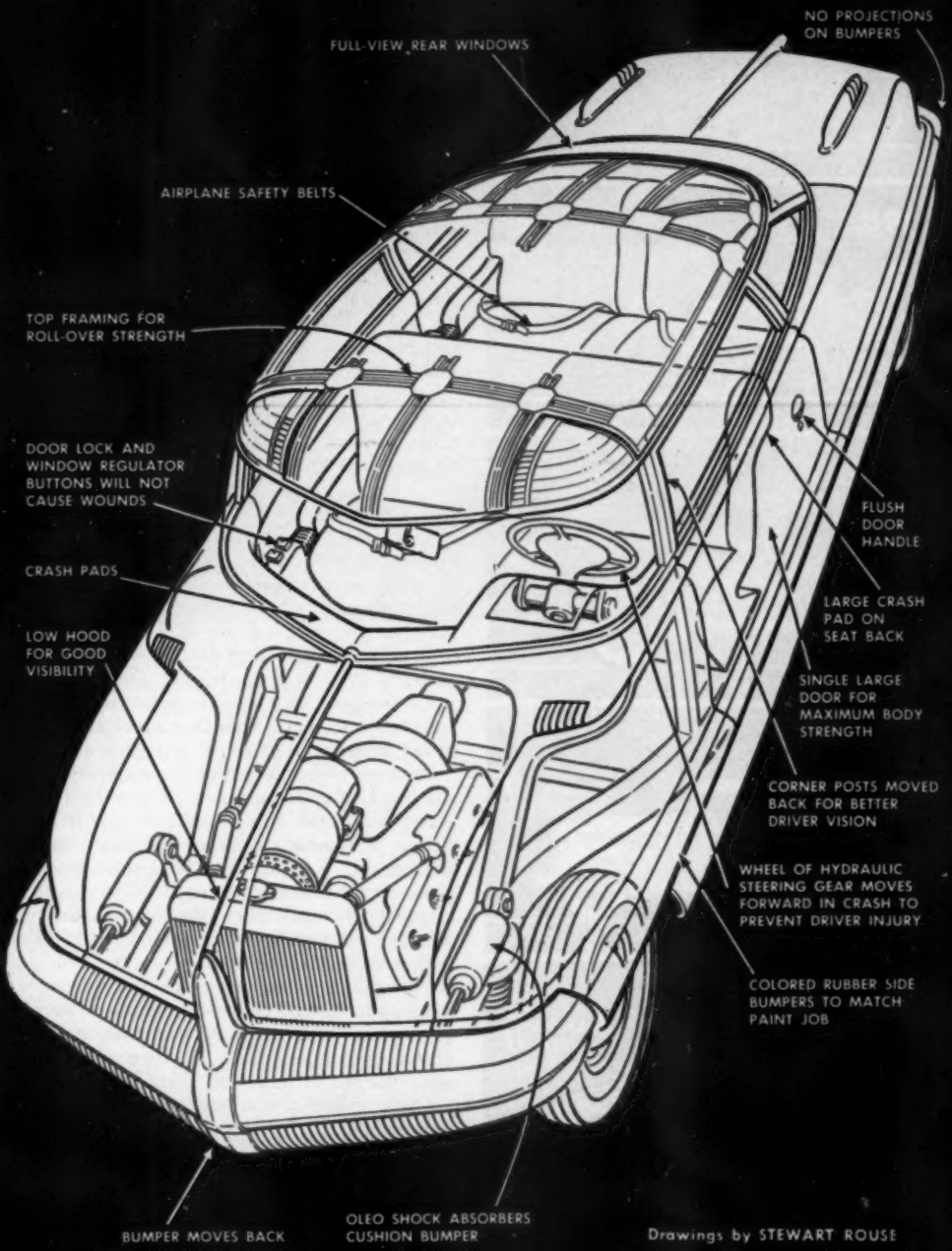
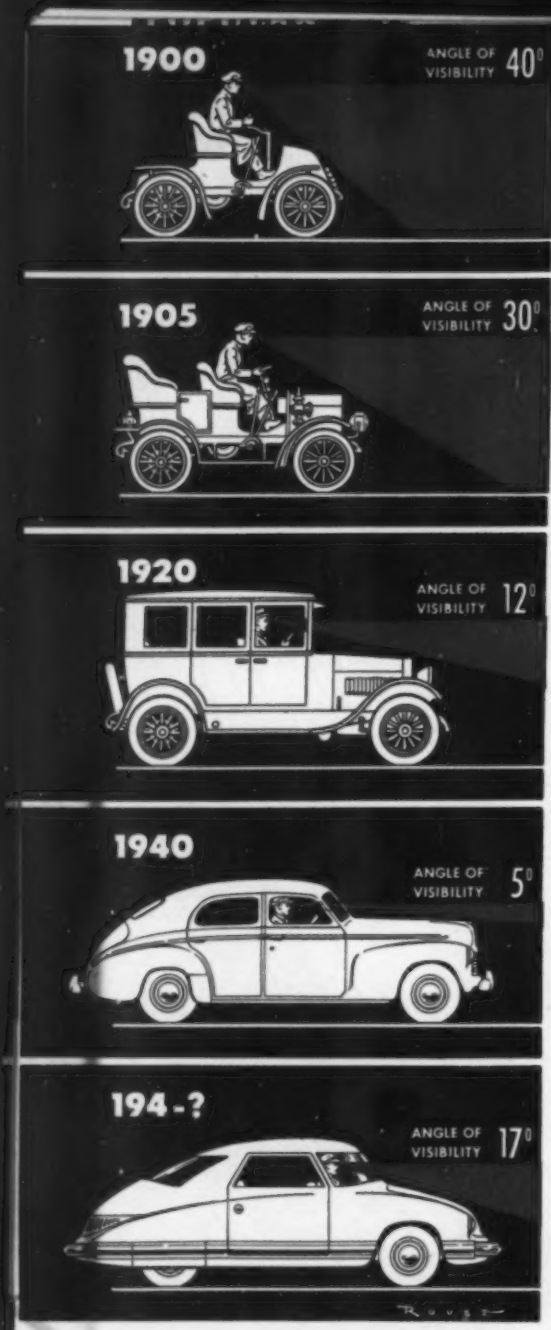
EDITOR'S NOTE: Last year *Popular Science Monthly* warned of the deadly toll to come in the first flush of motoring without fuel rationing. "How To Drive and Stay Alive" (PSM, April '46, p. 66) was a practical examination of what you, the man behind the wheel and the principal ingredient in every automobile accident statistic, could do to stay out of trouble.

This year PSM considers the car itself, the history of its structure, and its evolution as a safer vehicle for the transportation of human cargo. Out of PSM interviews with safety authorities and automotive engineers have come startling facts about life—and death—on wheels.



Drawings by STEWART ROUSE

Here is an artist's conception of what a safer car might look like. It's no dream; eventually, automobiles will include many of the items illustrated. This one could be built now, without waiting for a solution of the problems of weight and balance that make rear-engine design a thing of the future.



A substantial part of the highway accidents that killed 34,000 persons last year could be attributed to poor visibility from the driver's seat. As the drawings above show, visibility has been progressively reduced for years by the longer hoods, lower seats and shallower windshields that found favor with the public. Now visibility is gradually being increased from its hazardous minimum.

alike. Tens of thousands will die in traffic accidents during 1947. *You* may be one of them.

A lot *has* been done to cut down this carnage. More *can* be done. What is it?

I went to Detroit to find out, after some preliminary investigation in Boston, Washington and New York. I knew the automobile makers were sensitive about safety. Making automobiles is a blue-chip business. Any mistake in figuring what you, the motorist, will buy, can mean millions of dollars in losses. Even the most altruistic manufacturer could no more afford to make cars you *ought* to like than Hart, Schaffner & Marx could make suits without lapels. And lapels on a man's suit haven't been used for their original purpose—buttoning up the neck against the weather—for a century.

What Price Visibility?

U. S. buyers have made the auto makers very cautious about safety innovations. One manufacturer reduced the size of the grip on his steering wheel, not so many models back, to give you a better view of the road and of your instrument panel. What happened? You stopped buying that model until the grip had been fattened up by a fraction of an inch. That fraction of an inch didn't increase its strength a particle.

Another courageous pioneer rounded off the hood so you could get a better look at where you were going—and paid for it by losing customers. Another deepened the windshield. Nobody liked it. Drivers complained that they felt "exposed." They were satisfied, though, when the manufacturer blanked out the bottom of the windshield and reduced the visibility.

Nowadays, when you climb into an airplane, you fasten your seat belt as a matter of course. But the motor-car makers are afraid to put seat belts on their vehicles, even though 70 miles an hour is 70 miles an hour, whether you are in a plane or an automobile.

The Canvas-topped Killer

You insist on convertibles, which are a standing order to the undertaker. Even the manufacturers don't like convertibles. Every Detroit big shot I talked with about those canvas-topped killers said, "Not for my boy!" Some said there ought to be a law about them.

So automobiles are what they are for a perfectly logical reason: the collective pur-

A wide corner post can completely block out another car at a critical moment. The public put the corner post in the driver's eye by crowding three in front. It's still there, although seats have been widened and corner supports narrowed. A slimmer steering wheel would also increase visibility.

chasing power and *buying desires* of millions of people, you included.

In Detroit I asked a double-barreled question: *What has been done, what can be done, to make automobiles safer containers for people in motion?*

I found out that much had been done—in spite of you, the buyer. Safety glass and solid tops that will take the impact of a roll-over were only two items in a long list of improvements in the last four decades. The self-starter was introduced as early as 1911, the steel frame as early as 1914.

Safety Aids Galore

Here is an incomplete list of other safety innovations:

Tilt-beam headlights, prism lenses, windshield wipers, stop lights, indirect lighting of instruments, adjustable seats, balloon tires, four-wheel brakes, bumpers front and rear, heaters, hydraulic brakes, synchromesh transmissions, the foot dimmer switch, carburetor silencer and flame arrester, independent front-wheel suspension, the "turret" top, sealed-beam headlights, steering column gear shift and the 50-mile-an-hour warning light on the speedometer.

A lot of these changes were sneaked in by the back door so as not to disturb the customers. Many that were discussed couldn't be made. You have yet to see a car maker put a crash pad on the dash so a passenger wouldn't bash his head on it in a quick stop.

Faults by Inheritance

The automobile is what it is because it grew from a buggy with a back door. Today's car is a lineal descendant of the old side-winder of the early 1900's, a not-so-horseless carriage. Unlike the helicopter, which had to be engineered fresh and clean, the automobile inherited the ills of its ancestors. People insist, for example, on more doors in their automobiles than in their houses, even though the getting-in and getting-out time is piffling compared with the greater safety of structure that fewer doors would provide.

What would a car be like if the designers didn't have to keep thinking about what the public would and would not buy?

I found in Detroit that it is perfectly possible to build a safer car with existing components, without waiting for rear en-

gines or magic-strength materials. And I discovered, too, that the kind of a car Detroit would *like* to build for you actually *is* being built—little by little.

Little is the right word: Changes come slowly because the earnest engineers can't start from scratch; they have to begin with innovations that you, your aunt and your next door neighbor think are proper.

Advancing the Driver

Year by year, for a decade, car design has moved the driver forward. Now and then the hood got too long, but nonetheless the driver went forward in the chassis. The long hood, once expressive of power and the egotism of the driver, has been shortened perceptibly. It is going to be shortened more.

Experience with buses and cab-over-engine trucks has shown a decided advantage for this forward position. The driver, key man on the safety team, can see better. Moreover, with his own carcass right out in front, he is a little less likely to rely on the false safety of all that iron between him and disaster.

With the hood rounded down, the much-touted rear engine awaits a new day of lighter, more efficient engines. To transport people, a car must also transport luggage, and today's engines take less room than today's bags. So the best place for the engine is still in front.

What else? Not much, to the eye. But under the sleek roof, frame members will weld body to running gear. This is called "unitized construction." It's in some of today's cars. Whatever footage is ahead of you will be steel, not air under a glamorous hood.

Supports May Move

Corner posts are being thinned down for better visibility. They may be moved back, out of the driver's eye.

Cars also will be engineered to take a punch with less damage to flesh and metal. Today's bumper is only a bar to push a car around. It will fold or snap at anything over four miles an hour. Yet airplanes, engineered for bumps, hit runways every day with foot-pounds of wallop that would make an accordion of a car. My editor tells me he has seen 10-ton Grummans hit a flight deck on one wheel, with the oleos (oil-cushioned shock absorbers) in the landing gear taking up the whole shock. As a flier myself, I know that the oleos absorb the concussion of a lot of pilot error.

A safety feature would be the inclusion of stopping distances on the speedometer dial, reminding the driver how they shoot up as speed increases. The distances shown are for optimum conditions—halting the car on dry concrete. Slippery pavement or faulty brake action could skyrocket the figures.

So why not have bumpers with oleos? And why not admit, on the drafting tables, that cars must operate in traffic? With bumps inevitable, shock-mounted front and rear bumpers would sop up the abuse. Rubber side bumpers, colored to match the paint job, would save many a wrinkled side panel.

Helpful Headlights

The most dangerous driving, everyone knows, is at dawn, dusk and during the hours of darkness. Sealed-beam headlights already have helped to lessen the danger. Some engineers are thinking about putting the headlights higher, on the roof corners, to afford a greater angle against the road and keep them out of the eyes of the fellow passing you in the opposite direction. The same men who worked out the sealed-beam lights are now experimenting with polarized light. When it comes, the glaring beams that light the whole road will be a couple of dim discs to you.

Death on the road is shocking enough, but there are far more injuries than fatalities. Many of these less-than-fatal accidents have been avoided by better *inside* engineering and design. There are fewer cracked kneecaps because legs have been better

accommodated in the front seat. There are fewer broken noses because the backs of front seats have been padded for the benefit of rear-seat riders.

Problems of Impact

The safer car to come will present a smooth, soft surface to bodies that are involuntarily catapulted forward in sudden stops. That brings up another story which makes you, the customer with the dollar in his pocket and his neck out, look a little foolish. One company actually designed a leather-covered, crash-padded dash. Then the vice-presidents in charge of engineering and profits got cautious. They feared the impact on the market of a car that confessed the realities of danger in driving. So they substituted a nice decalcomania of leather-covered dash right on the steel!

Aside from such reluctance, and the public attitude that causes it, the advantages of crash padding are obvious. A 2,500-pound automobile develops 302,000 foot-pounds of energy at 60 m.p.h.—enough to do a lot of damage if anything gets in its way. A braking action of 4/5 gravity, which is common, throws a person forward with a force of 4/5 his own weight; if an automobile structure in a collision will withstand an impact of four times gravity, a passenger is bound to get hurt unless there is something in front of him to soften his landing.

The problem of safety in impact is simply one of controlling the rate of deceleration. Hit a steel plate with your fist and you skin your knuckles; hit a pillow, and your hand is unhurt. For this reason, automobile makers regard the "crumple rate" of fenders, body and framework as a safety factor in collisions.

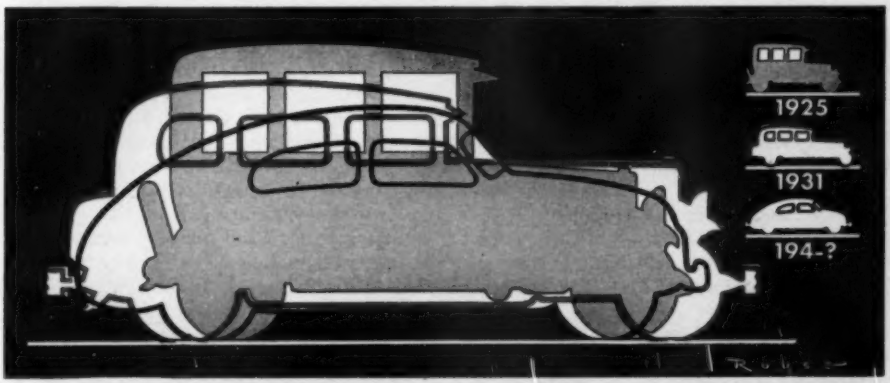
In terms of impact, because of its sheer weight as a projectile, a heavy car is more dangerous than a light one—so cars are being lightened. Hundreds of pounds are being stripped off with all-welded construction, and further weight reduction is being explored by cutting down mechanical friction.

Even a medium tank cocooned with foam rubber would not be as safe—if it hit another medium tank—as a car on a pedestal, with an empty gas tank, in the Smithsonian Institution. But cars will be made safer as soon as the American people give the manufacturers the green light.

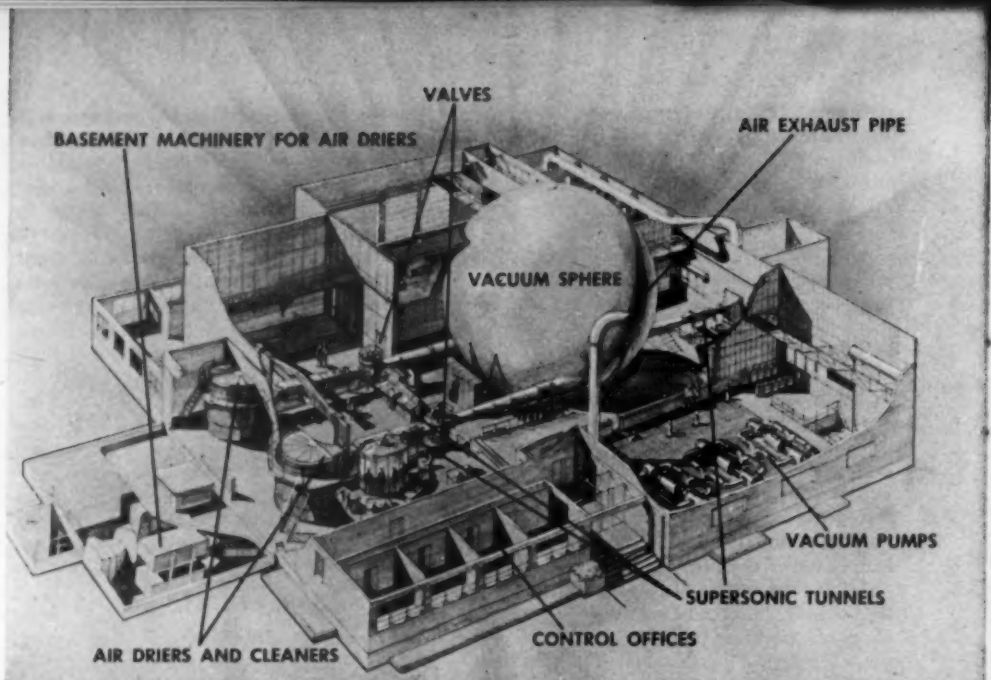
Safety Isn't Gratis

Already an automobile is the second largest collective investment (a home costs more) of the typical American family. Safer cars are likely to cost more. You can't put welds and ribs into a frame for free. And auto makers cannot bet against your whims.

You won't get a really safe car, soundly engineered and sensibly designed for modern traffic, until you are willing to pay the price of safety. That price will mean a few more payments and fewer foolish notions about what a car ought to look like standing still. END



Once high and short, then long, cars are getting more compact and closer to the road. Other changes involve weight, which is being reduced, but engineers are restricted by the rough necessity of a 50-50 front and rear balance. Incorrect weight distribution could multiply the hazards of applying brakes on a curve, for example, because of "slippage," or normal side-skid.



NAVY Rebuilds V-2'S CRADLE

INCLUDED in the new Naval Ordnance Laboratory being built at White Oak, Md., are three German supersonic wind tunnels that have been transplanted from Kochel, Bavaria. The supersonic German "factory" is described as far ahead of any other apparatus in the world for simulating speeds beyond that of sound. It was in this plant that experimental work was completed on the V-2 rocket used to bombard London in the closing days of the war. The plant was first built at Peenemunde, in Northern Germany, but was moved to Bavaria when Allied bombings got too heavy.

The entire complex of tunnels was disassembled and crated for shipment to the United States after Lyman G. Fisher, assistant director of the mechanics division of the naval laboratory, went to Germany in September 1945 to inspect the captured equipment. "One of the most striking features of the Kochel tunnel design," he reported, "is the economy of operation it achieved. Actually a series of tunnels, the Kochel installation utilizes an ingenious method of intermittent operation, making it possible for the tunnels to be operated with remarkable efficiency on a fraction of the power required for a continuous tunnel of comparable size."

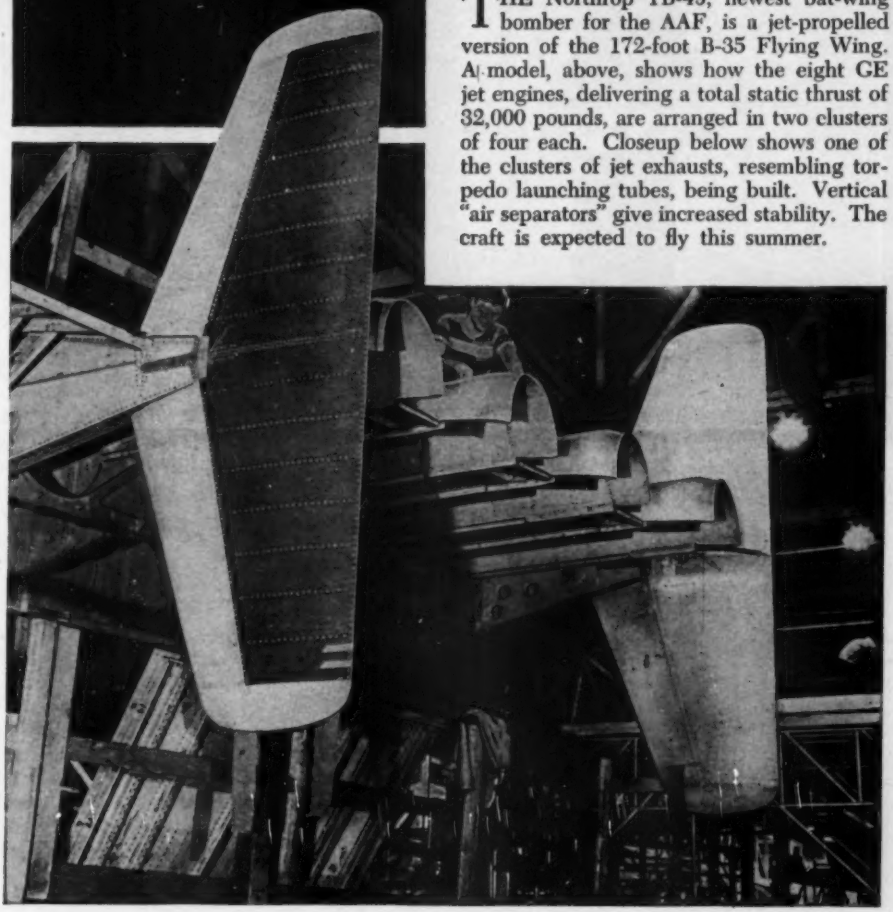
The tunnels will be used in developing projectiles and rockets for use at speeds beyond that of sound. The tunnels operate at less than atmospheric pressure. Atmospheric air is drawn through the tunnels by suction, created when vacuum pumps exhaust the air from the huge spherical chamber shown in the illustration above. The flow of air starts through two of the three tunnels with the turn of a valve. The tunnel at rear of the sphere has no valve because it was built for velocities that would just match the capacity of the pumps.

Structures in rear of plant contain smaller experimental tunnels. Pipe at top in background supplies such tunnels with air.

German experts achieved tunnel speeds almost 4½ times that of sound, or roughly 3,350 miles an hour. The only comparable U. S.-built tunnels are at the laboratories of the National Advisory Committee for Aeronautics at Sunnyvale, Calif. (PSM, July '46, p. 66). The entire Naval Ordnance Laboratory project will cost $15,000,000.

Flying Wing Goes Jet

THE Northrop YB-49, newest bat-wing bomber for the AAF, is a jet-propelled version of the 172-foot B-35 Flying Wing. A model, above, shows how the eight GE jet engines, delivering a total static thrust of 32,000 pounds, are arranged in two clusters of four each. Closeup below shows one of the clusters of jet exhausts, resembling torpedo launching tubes, being built. Vertical "air separators" give increased stability. The craft is expected to fly this summer.

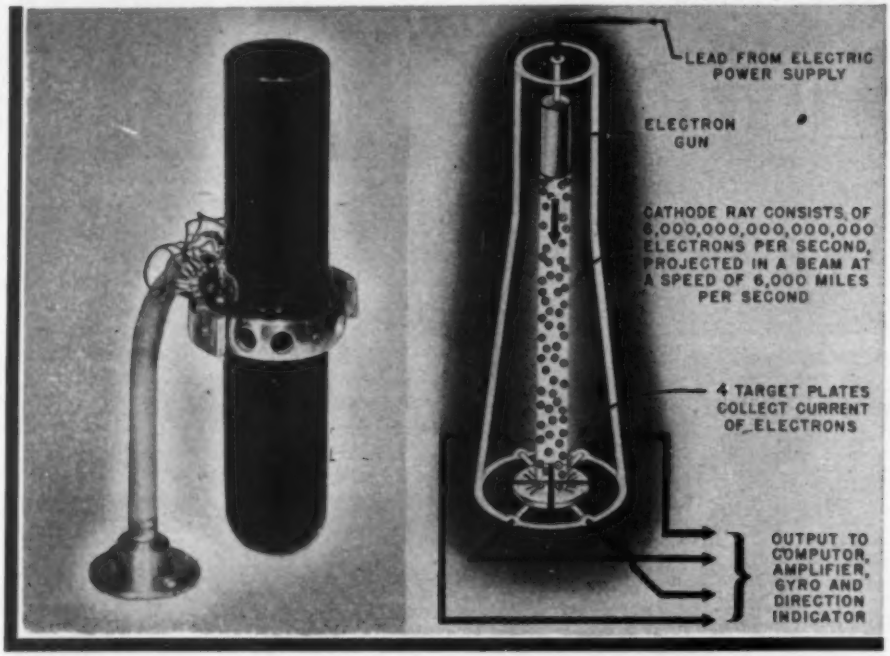


Steering by Electrons

ALREADY overworked electrons have taken on still another job. The Cathotrol, a new compass, uses the magnetic deflection of an electron beam to tell direction.

Developed by the Minneapolis-Honeywell Regulator Co. for aircraft and ship navigation, it is essentially a flashlight-size cathode-ray tube (at left, below) suspended face down from a universal joint. Instead of a fluorescent screen, however, its downward beam of electrons (at right, below) strikes a four-segment metal target.

A slight but constant westward deflection of the electron beam, caused by the earth's magnetic field, is registered on the target and actuates a compass indicator, corrected to read North instead of West.



Pipe Solves Match Problem. A novel pipe features a built-in lighter and a chamber that precools the smoke and condenses hot tars and fluids. Made by the Birch Regal Co., it requires no filter and is cleaned by moving a pistonlike plunger inside the barrel.

Pound of Poison KILLS 200,000 Rats

ANTU must be used wisely to destroy whole colony at once.

By GEORGE H. WALTZ, JR.

SCIENCE is working from A to Z in its war against disease-carrying pests. A few years ago DDT made its debut as a sure-fire pest weapon for home use. Now a new one—ANTU—has been added to the alphabetical arsenal.

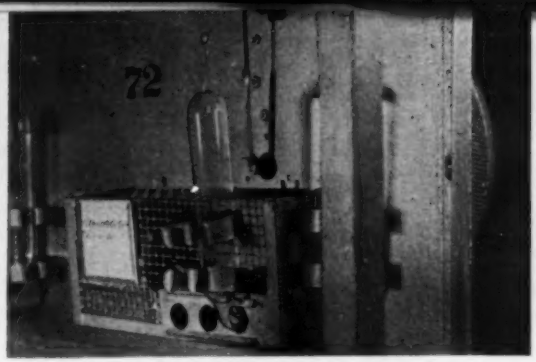
ANTU is to rats what DDT is to insects—a powerful, quick-acting, one-shot poison that is easy to use. But like DDT in its field, ANTU has its limitations as well as its virtues, and to get the most out of its rat-killing powers you must know those limitations, as well as its dangers and the right way of using it.

First of all, ANTU is a specific poison for the brown or Norway rat, which comprises about 90 percent of the rat populations in our towns, cities and farms. Although so deadly that one pound of the fine grey-blue powder is enough to kill 200,000 rats, it has little or no effect on mice and other rodents. It can kill cats, dogs and farm animals if it is not used properly, but so far as is known at the present it has no bad effects on humans unless taken in large quantities.

ANTU was discovered quite by accident six years ago by Dr. Curt P. Richter at the Johns Hopkins University Hospital, in Baltimore, Md. Dr. Richter, searching for new facts about human diet, was testing his theories on a colony of laboratory rats. At one point in his experiments he decided to test the taste reactions of his rats, as compared to humans, and fed a group of six rats tiny pinches of phenyl thiourea, the bitterest substance known to man and often used without danger in taste-reaction tests on humans. Two surprising things happened—none of the rats seemed to taste the bitterness of the chemical, and by the next morning all six of the rats were dead!

Dr. Richter's thinking shifted quickly from diets to rats. Had he stumbled on a new "safe" rat poison? At the time, "red squill" was the most widely used poison, but the Axis occupation of North Africa had cut off the chief source of supply. The ques-

ANTU was discovered during research into the taste reactions of rats in this laboratory at Johns Hopkins University. Here laboratory rat is weighed as part of study of relation of diet to health.



This cage is home sweet home to a Johns Hopkins rat. At far right can be seen edge of revolving drum where he works out. He often runs 40 to 50 miles a day, recorded by counter above the cage.

tion was, would phenyl thiourea kill wild rats as quickly and as thoroughly as it had his laboratory pets?

To find out, Richter trapped a few wild rats on the city dump. Unfortunately, the wild rats proved far wiser in their choice of food than their laboratory relatives. No amount of camouflaging or trickery could get the wild rats to taste the chemical. They turned up their collective noses at even the most attractive bait when it was mixed with the poison. The wild rats could taste the bitterness of the phenyl thiourea where the tame laboratory rats had not.

Richter, however, didn't give up. Perhaps some other similar chemical would do the trick. One by one he tested more than a hundred thiourea compounds in the hope of finding one that would be deadly and that the rats would eat. His search finally led him to the chemical called alpha-naphthyl thiourea, which he shortened to the less tongue-twisting name of ANTU. Wild rats found it palatable—and fatal.

Baltimore Rats Slaughtered

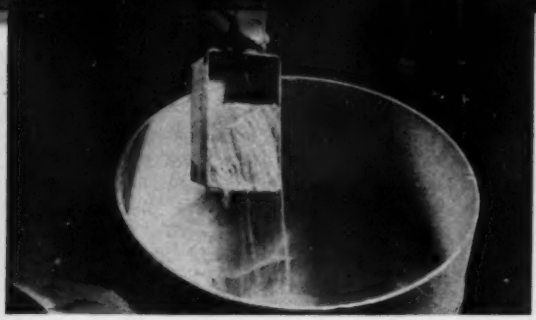
This was late in 1941, at a time when Baltimore was having more than its share of rat troubles, so Richter had to do little more than step out of his laboratory to find a perfect area for a field test. After an initial trial covering eight square blocks proved highly successful, the city government took over the fight, first with trained volunteers and later with additional regular paid workers. The rat colonies were exterminated systematically, block by block. The rat death rate in many cases was close to 100 percent. It has been estimated that during a one-year period more than 45,000 rats were killed with ANTU. As a result, Baltimore now has a City Rodent Control Office and more than three-quarters of the densely populated sections of the city have been brought under control.

ANTU is now available to the general public, but before you use it, either in its pure form or in the form of one of the ANTU prepared baits being sold commercially, you will be wise to study your rats as well as the poison.

Careful Planning Essential

Anti-rat campaigns with ANTU must be carefully planned. ANTU is a one-shot poison; it is not accumulative. Success depends upon getting the rats—and that means all the rats—to eat a good portion of the poison. Their first free meal must be their last. Unfortunately, anything less than a killing dose allows the rats to develop a partial immunity to the poison that lasts about 30 days and an aversion to it that may linger for several months.

Don't attempt poisoning operations on a small scale. The area to be covered is determined by two factors—the location of the building or buildings to be treated and the natural habits of wild rats. Unless they are chased by dogs or cats, or the supply of food is completely removed, rats seldom journey far from home. However, they generally live in one place and eat in another. For this reason, when rats are to be cleared from a farm, or property in the less densely populated portions of a suburb, all outbuildings as well as the main house should be treated with poisoned bait. In sections where the houses are of the so-called "detached" type, groups of neighboring home



The pure ANTU in this bucket is a fine blue-gray powder. The poison can be used in this pure form, mixed with food or water, or in a commercial bait.

A tablespoonful of the poisoned bait—here a cornmeal mixture—should be placed in a small pile just to one side of a known rat hole or burrow.

Rat burrows can be sprayed with pure poison: The rat will get the powder on his feet and hair and lick it off. ANTU is also spread along rat runs.

One of best methods is to dust an ample layer of ANTU onto a foot-round pile of corn meal spread on the floor in an area rats frequent.

PSM photos
by W. W. MORRIS

owners should co-operate in one general anti-rat campaign. In cities, where the houses are built one against the other, a complete block is the smallest area that should be treated as a unit. Unless a city home is completely ratproofed, there is little sense in attempting to rid it of rats if the surrounding homes remain rat-infested. In crowded districts, rat control should be a community problem.

Rats Often Unseen Guests

The area to be treated with ANTU first should be carefully surveyed to locate all rat holes and burrows, runways (generally found along walls or fences), possible sources of food, sources of drinking water, and entrance holes leading into homes and outbuildings. These are all good spots to place the poisoned bait. Watch for signs of rats—droppings and telltale teeth marks on soap, food, wood or cardboard boxes. If there are signs of rats but you have never seen one, you are more than likely playing host to from one to 100 of them. If you see them occasionally at night, the colony in your vicinity may number 200. And if you see them during the day as well as at night you are surrounded by an army that may number more than 500.

Straight or Mixed

Pure ANTU, which costs about $4 a pound, can be used effectively in a number of ways. A good ground bait can be made by mixing two to three parts of ANTU with 100 parts of finely ground, fresh yellow corn (corn meal). This can be distributed in small shallow piles (about a tablespoonful) where rats are known to be. A good spot for this type of bait is just to one side of the entrance to a known hole or burrow.

Another similar procedure consists of smoothing out a layer of corn meal about one-quarter inch thick and one foot in diameter and dusting it with the ANTU powder from a spray gun or an ordinary kitchen flour shaker. This particular type of bait works well on cellar or outbuilding floors. Small slices of apple, cantaloupe, watermelon, sweet potato and tomato,

or ground meat, the white and yolk of eggs, and chicken and fish heads can be dusted with the poison and used in much the same way. When using either of these baiting methods, it is wise to dust an additional area with ANTU around the food for a distance of six or eight inches.

ANTU can also be used without bait. Mixed half and half with ordinary flour it can be pumped into holes and burrows or spread along runways. When the rats get the powder on their feet or hair, they lick it off and get their poison without eating—victims of their personal cleanliness.

In places where food is plentiful and there is no means of conveniently removing the supply, such as in food stores and warehouses, the rats' thirst can be catered to by putting out shallow dishes of water that have been dusted with ANTU. The poison should be dusted on the water until a thin floating layer has formed on the surface.

Combined Attack Most Successful

In any anti-rat campaign it is best to use a combination of these baiting methods and, in any case, it is wise to pre-bait for a short period before applying the poison. Set out *unpoisoned bait* in the same spots for three or four nights in a row, or at least until you are sure that the rats in the vicinity know where the food is. Word of the free lunch will spread rapidly through your rat colony. You can check on the nightly attendance at your rat cafeteria by looking each morning to see how much of the unpoisoned food has been eaten. If the amount consumed increases each night, continue to pre-bait with fresh food; but once the shrinkage of the piles remains constant you can be pretty sure that the word has spread to the last rat—and remember, it's that last rat that counts. That night you can set out your ANTU bait with fair assurance that you will get close to a 100-percent kill.

Since rats generally eat shortly after dark and early in the morning, put your bait out late in the afternoon. During the pre-baiting and baiting period be sure to remove all other possible sources of food. Then, on the night that you set out the poisoned bait, be sure to keep your children, pets and farm animals away from the poisoned area. After the poisoning operation is completed (the next morning), remove all poisoned bait and dispose of it where humans or animals are not likely to get at it.

Block Holes on Third Day

ANTU-poisoned rats usually die within 10 to 24 hours, so look for dead rats for several days following the poisoning. On the third day close all rat holes with dirt or stones. If any rats remain, the holes will be reopened within a few days.

ANTU kills by affecting the rat's lungs and the production of lymph fluids—in other words, the rat literally drowns in its own body fluids. This is an important feature of ANTU, since by affecting a rat's breathing it usually drives him outdoors to die.

ANTU does not guarantee against reinfestation, so keep a careful watch for rat signs. If necessary, repeat the process within a year.

Rats cost American home owners and farmers $63,000,000 annually. One rat can eat up to 50 pounds of grain a year. ANTU—plus constant vigilance—may save millions of this tribute to ratdom. END

ANTU DON'TS

Don't leave ANTU or poisoned bait around where children, pets or farm animals can get at it.

Don't leave poisoned bait out for more than 18 hours. Collect all uneaten bait and dispose of it carefully.

Don't throw unused poison or bait into garbage or swill that might be used as food for pigs.

Don't use ANTU where there is any likelihood of contaminating food.

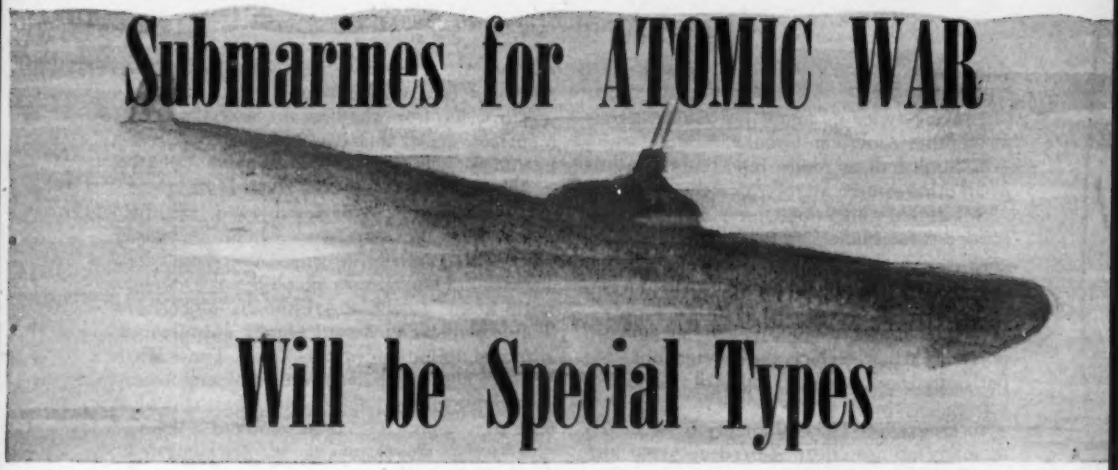
Don't be stingy with your poison. Give your rats plenty of food and plenty of poison.

Don't relax your war on rats after one successful treatment. Repeat your ANTU campaign at least once a year if necessary.

Don't use ANTU unless you are sure of covering the entire rat-infested area.

Don't forget—it's the last rat that counts.

Submarines for ATOMIC WAR



Will be Special Types

Attack, picket, transport, cargo, aircraft carrier and guided missile ships will supersede all-purpose, fleet-type subs.

By LEON SHLOSS
PSM Washington Editor

ON April 11 the United States Navy celebrates Submarine Day, in honor of all American submariners and especially the 55,000 who helped win World War II. Even while the nation pays tribute to the undersea fighters' past exploits, however, Navy strategists are studying plans for their future —in a submarine fleet comprising at least six different types of ships that can carry out all the missions of Atom Age warfare while escaping most of its perils.

The Navy high command believes that, as of today, the submarine cannot be consistently detected or continually followed—as, by radar, the surface ship and the airplane can—and that it is the least vulnerable of all types to atom bomb attack. The latter was indicated at Bikini. The former, in the words of Fleet Admiral Chester W. Nimitz, is assured until "electronic waves are able to make reasonable penetration of sea water."

It is also realized and readily admitted, in the quiet cubicles of the Navy Department where the continued American freedom of the seas is being assiduously planned, that both Germany and Japan—especially Germany—were way out in front of this country in submarine development at the end of the last war. Considering that the United States escaped the catastrophic potential of such a situation, the planners declare we were lucky because the Navy can now start to build from scratch without having to scrap a lot of valuable equipment. Further, it possesses and is using all the technical knowledge that the late enemy built into its pigboats.

Neither Admiral Nimitz nor his strategists are convinced that the new submarines will eliminate surface navies. They point out that within the last century the architecture of navies has been changed by steam, steel, the screw propeller, the long rifle, the torpedo, the mine, the submarine and the airplane. They know it will be further altered by atomic energy but declare that as long as world commerce moves above, on, or under the oceans there will be need for diversification of ships to protect the sea lanes ("Navy Plans to Go Higher and Deeper," PSM, April '46, p. 82).

Following this philosophy, the Navy intends to overlook no bets if the submarine, as presently indicated, turns out to be *the* warship of the "near future." Naturally, long-range plans for super-submarines are on the drawing boards. It is not with these that the Navy is so immediately concerned, but with the so-called "fleet type," which compiled such a diversified record in World War II. Outdistanced technologically as these

ships were at war's end, they nevertheless had:

1. Sunk twice as many Jap cargo vessels as all other American forces.

2. Sunk half as many Jap combat vessels as all other American forces.

3. Landed raiders on enemy islands, bombarded these islands, and recovered the raiders.

4. Rescued more than 500 American aviators from the sea.

5. Laid mines, carried fuel to beleaguered positions when surface ships could not, and performed outstanding feats of reconnaissance.

6. Destroyed 275,000 enemy lives, nearly as many as the entire American Army lost.

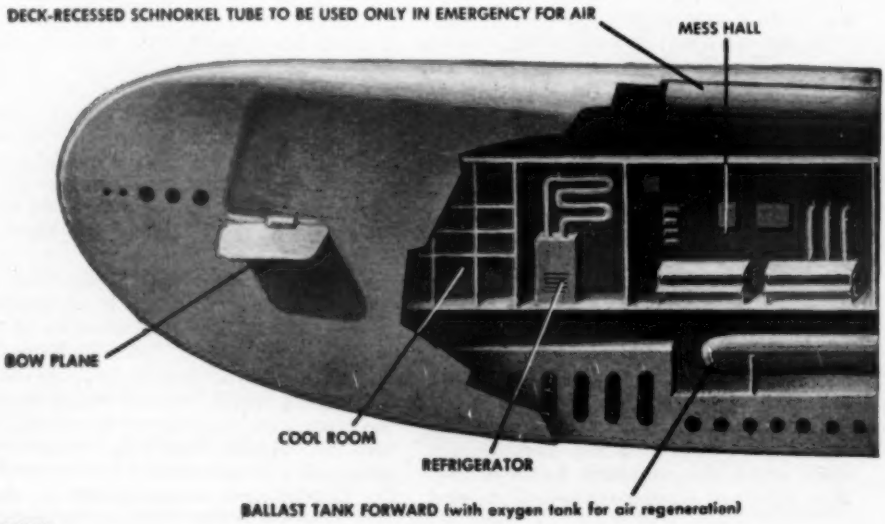
All that got the Navy to thinking. If a mutant vessel like the submarine—never recognized as being good for much besides stalking targets of opportunity—could accomplish such varied tasks with such great success, what might not a fleet of undersea craft, broken down into more specialized types to perform specific tasks, do?

The new submarines, by and large, will be about the same size and weight as World War II subs. They can be produced quickly and still incorporate the latest technological advances. This will be the submarine of "tomorrow," not "day after tomorrow," but still built for the first time as a submarine from the keel up, not merely as a surface vessel that can submerge when it becomes necessary.

All the new types will have high speed and long range while submerged, on the principle that, from now on, the surfaced ship is the vulnerable ship. Speed will be limited only by power-plant developments, with atom power the ultimate objective. Range will be governed almost entirely by physical limitations of personnel. These limitations will depend on ability of engineers to provide continually improving air-revitalization systems. The food problem is being solved by development of concentrated foods that will keep crew members well above subsistence levels for long periods, without heavily burdening the submarine with supplies.

The speed factor will be increased by streamlining wherever possible. This streamlining is being accomplished by dispensing with deck armament and other external impedimenta, even by reduction of torpedo capacity and internal load.

The six types of submarines now visualized as components of an Atom Age fleet, along with specifications and missions, are:

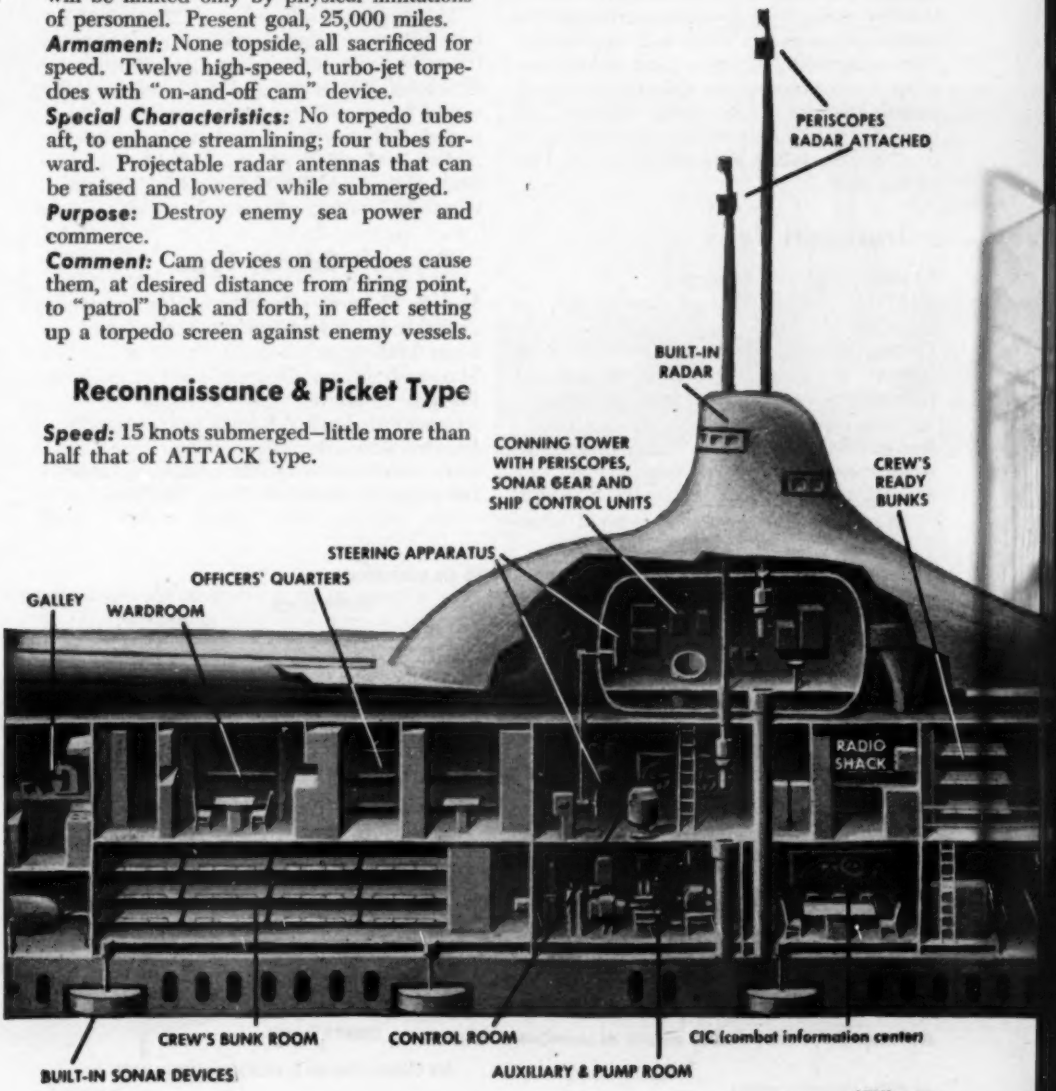


Attack Type

Speed: 26 knots submerged, or highest possible for quick strike and withdrawal.
Size: Present submarine size (1,800 tons, 310 feet long) or perhaps slightly smaller for higher maneuverability.
Shape: Ultimate in streamlining, for speed and maneuverability.
Range: As new power plants emerge, range will be limited only by physical limitations of personnel. Present goal, 25,000 miles.
Armament: None topside, all sacrificed for speed. Twelve high-speed, turbo-jet torpedoes with "on-and-off cam" device.
Special Characteristics: No torpedo tubes aft, to enhance streamlining; four tubes forward. Projectable radar antennas that can be raised and lowered while submerged.
Purpose: Destroy enemy sea power and commerce.
Comment: Cam devices on torpedoes cause them, at desired distance from firing point, to "patrol" back and forth, in effect setting up a torpedo screen against enemy vessels.

Reconnaissance & Picket Type

Speed: 15 knots submerged—little more than half that of ATTACK type.
Size: Present size or smaller.
Shape: Streamlining commensurate with special purpose.
Range: As above.
Armament: None.
Special Characteristics: Room for variety of radar, including long-range, aircraft, surface search. All radar antennas retractable for submerged operation. Good periscope



photographic facilities. Good communications facilities, also with retractable antennas for operation while submerged.

Purpose: Patrol and spotting, origination of radio reports on enemy dispositions and installations to American attack forces. May work in team with ATTACK and AIRCRAFT-CARRIER types.

Comment: On this and other types, all antennas must be retractable for underwater operation to preclude great danger of detection by enemy radar when surfaced. To contain all necessary radar and communications equipment, this type must make a sacrifice in streamlining and therefore in speed. Speed loss can be accepted, because primary function of recco sub is to remain in danger areas indefinitely and report vital information.

Transport Type

Speed: 15 knots submerged.

Size: Three times that of present subs, or about 6,000 tons.

Shape: As with the transport aircraft, as opposed to the military aircraft, streamlining is sharply reduced to permit increased carrying capacity.

Range: As above.

Armament: Large rocket launchers and anti-aircraft guns on deck for defense against enemy attack and before-landing barrages.

Purpose: Landing of troops for commando, espionage and other behind-the-lines activities and for evacuation of personnel.

Comment: About 600 equipped, special-purpose troops can be carried. Submarines transported as many as 300 Marines per unit in World War II.

Cargo Type

This type will differ from TRANSPORT type only in compartmentation and purpose. It would be built for adaptation either as a dry-stores carrier or a liquids carrier. It would be used to deliver supplies to besieged garrisons or critical war-production materials to allied powers. Might work in team with TRANSPORT type in following up attack landings with supplies.

Aircraft-Carrier Type

Speed: 15 knots submerged. Higher speed desirable but impractical under load factor.

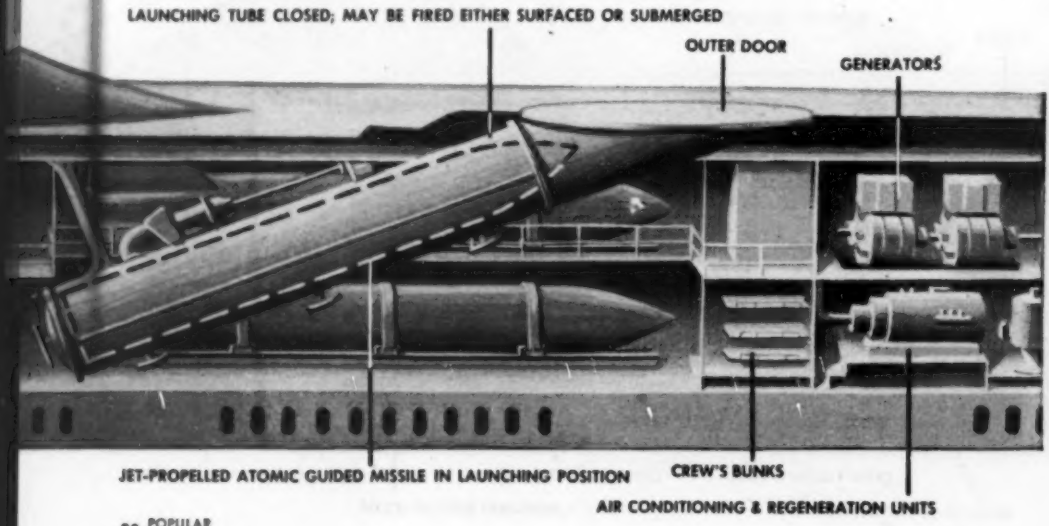
Size: 6,000 tons.

Shape: Bulky.

Range: As above.

Armament: Deck AA guns.

Special Characteristics: Hangar space, aircraft maintenance facilities, plane catapult, radar, good communications facilities, ca-

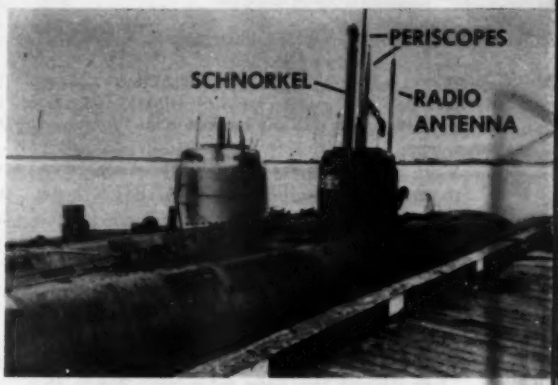


pacity to carry the fuel required by aircraft.
Purpose: Extension of scouting range beyond that of recco sub. Aircraft scouts could fly well beyond recco's radar range and report back by radio on enemy naval groupings. Secondary purpose, dropping of atomic bombs.
Comment: Bombing value of sub-borne aircraft is depreciated by planners, who foresee development of guided missiles with longer range and greater accuracy. Also low-rated is the possibility of pilot survival and recovery; hence, even scouting missions over land installations, which can usually be more heavily defended than sea forces, are ruled out except in unusual situations. The Japanese at the end of the war had several of the 3,000-ton I-14 class, which carried two planes each, and a couple of the 5,000-ton I-400 class, each of which carried four planes. Each plane could carry only one 1,500-pound bomb. Planners agree that this is not an economical manner in which to mount an effective aerial bombardment force and fail to see the plane-toting pigboat as a successor to the surface aircraft carrier.

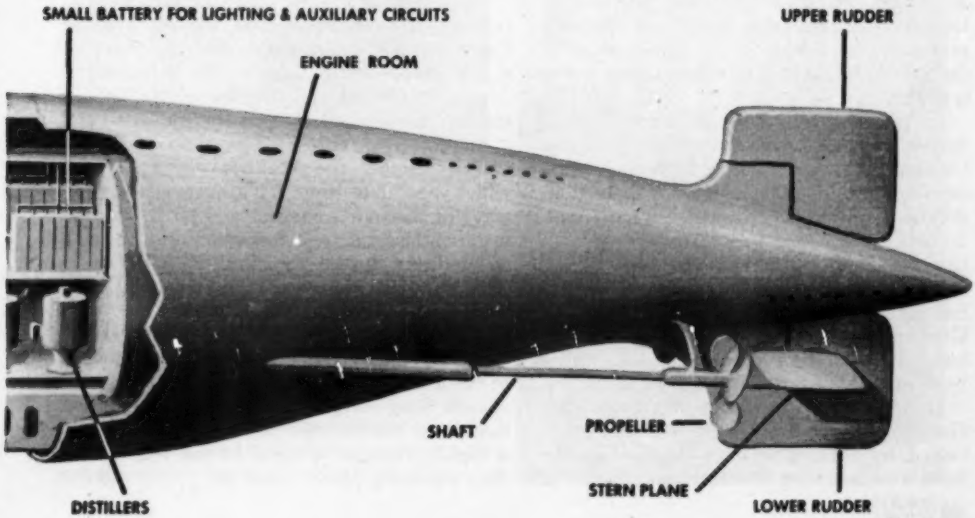
Guided-Missile Type

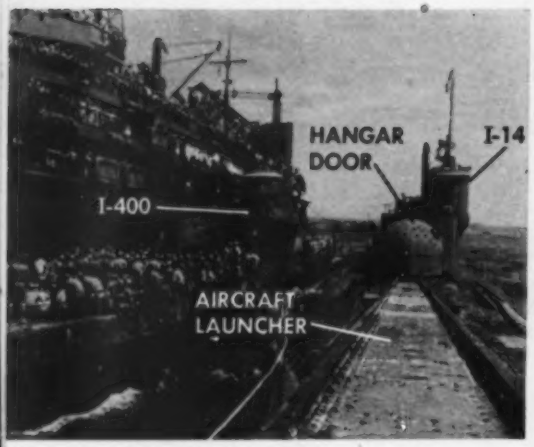
Speed: 24 knots submerged, or highest speed possible to evade coast defenses.
Size: Slightly larger than present sub-

This Type 21 German submarine shows the Nazis' advanced streamlining. All unnecessary gear has been stripped from her deck. Even the guns are gone.



Two captured Type 21s. Schnorkel—breather tube—and elaborate periscopes and radio antennas are extended on sub at right, retracted on craft at left.





The captured Jap submarine I-400 (left) carried four bombing planes; the I-14 (right), two. The I-14's launching rails can be seen in the foreground.

This angle shot of the I-14 gives a clear view of the railed ramp for launching planes carried in the space behind the bulbous hangar doors.

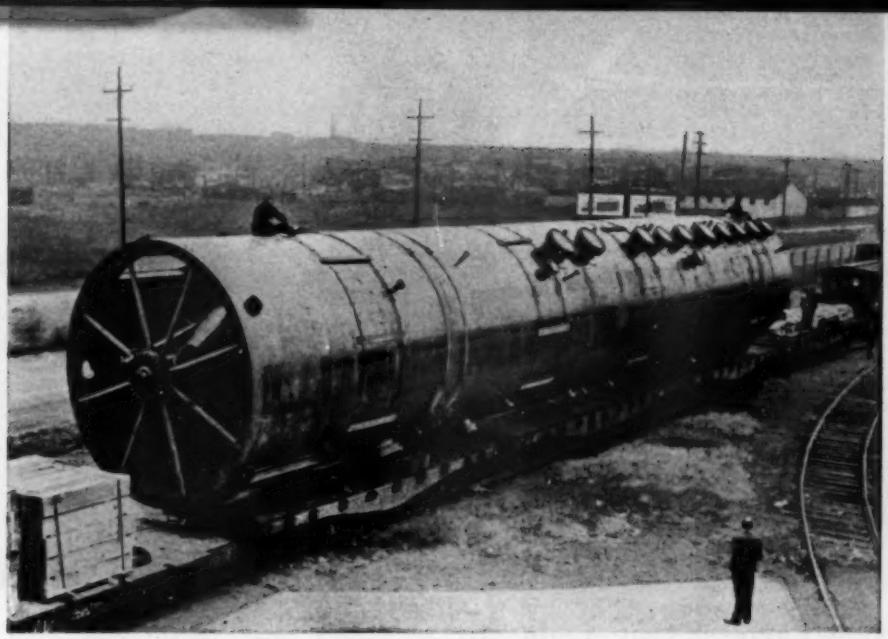
marines, but smaller than CARRIER type.
Shape: Moderately streamlined.
Armament: No defensive armament.
Range: As above.
Special Characteristics: Weapon launcher.
Purpose: Long-range, total destruction of enemy industrial and military centers.
Comment: Where the ATTACK type is the "left jab" of the new submarine Navy, the GUIDED-MISSILE type is the Sunday punch. Long-range, electronically directed missiles of at least 20,000 pounds will be launched, either submerged or surfaced, at ranges up to 500 miles. Submerged launching is the planners' goal because probability of detection and interception of the missile while it is traveling under water is slight.

In planning the new submarine Navy, American experts have the advantage of the German skill that produced Nazi U-boats capable of submerged speeds of more than 20 knots and submerged ranges of more than 20,000 miles. This was accomplished at a time when our best submerged performance was two knots for 40 hours or eight knots for one hour. Admiral Nimitz says that the German Type 21, developed in 1944, might have changed the course of the war had it been available in quantity two years earlier.

One of the developments that gave Germany its lead is the Schnorkel. Borrowed by the Nazis from the Dutch, the Schnorkel is a tube which extends from the engines to the surface and supplies the power plants with air to permit cruising at periscope depth without using batteries for power. Without this device, American submarines had to use low-voltage, long-life batteries for periscope cruising, as their Diesel engines were useless without air. However, with the Schnorkel, the Germans could use high-voltage, short-life batteries for short bursts of speed when fully submerged. This helped mightily in runs into and out of target areas so fast that depth charges could not be dropped effectively.

At the end of the war, the Germans were building an even better type, the 26. With a small, almost indiscernible conning tower, it had three power sources. At Schnorkel depth, it cruised on Diesels. Fully submerged, it used batteries. For battle speeds, it employed an entirely new type of submarine engine, the Walther gas turbine, which operated thus: Hydrogen peroxide was put through a catalyst and broken into water and oxygen, which gave off heat. Fuel was fed into this hot mix, and the gases expanding from the resulting combination drove the turbine.

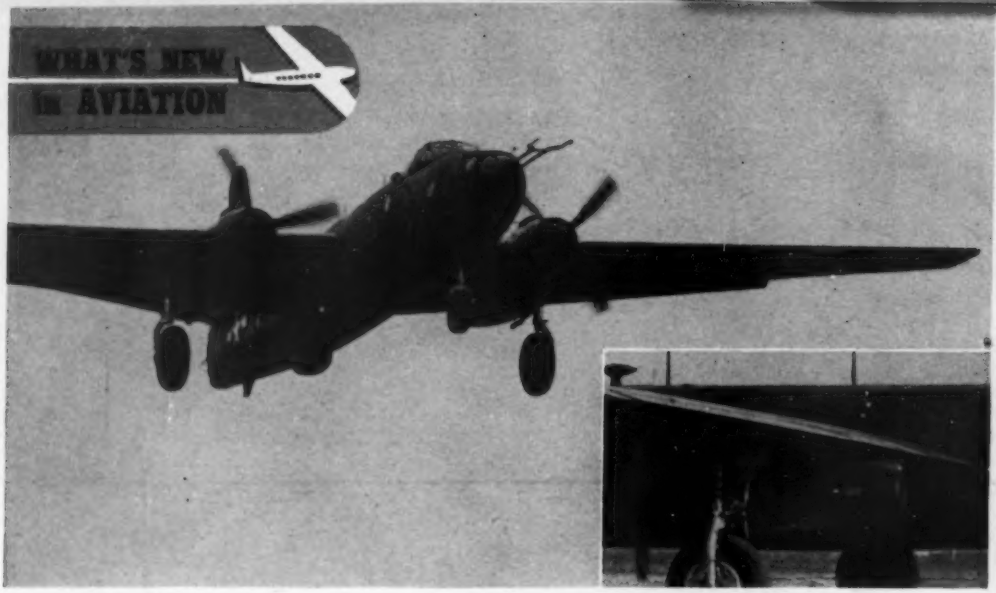
The American planners know all about these and many other things, the purpose of which was to attain high submerged speeds, long range and the characteristics that have transformed the submarine into a highly versatile weapon of sea war—and they are doing plenty about it. END



Big Tower Gets a Long Ride. It took a tugboat, a barge, and three flatcars to haul this giant 165-ton oil-refining tower from New Jersey to a refinery in Sugar Creek, Mo. The 2,025-mile trip, made largely on water, took 32 days—good time for this traveler.

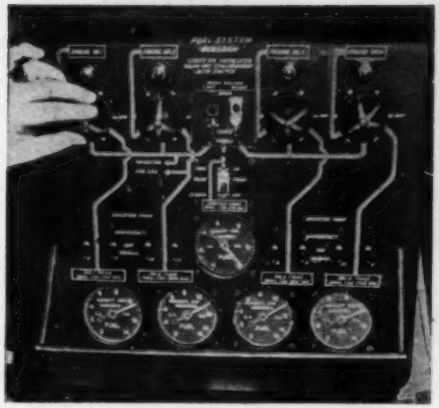
Bulldozer Rides the Rails. A rail-traveling bulldozer (above) is used in a unique method of track-grading devised by Hamer Brothers, Inc., of Detroit. Riding atop earth-piled flatcars, the bulldozer dumps the dirt along the tracks. Steel runways permit the tractor to move between the flatcars.

Boiler Takes to the Air. One of two 16,000-lb. steam boilers (below) is raised to the roof of an 18-story building in Dallas, Tex., for a new heating technique.

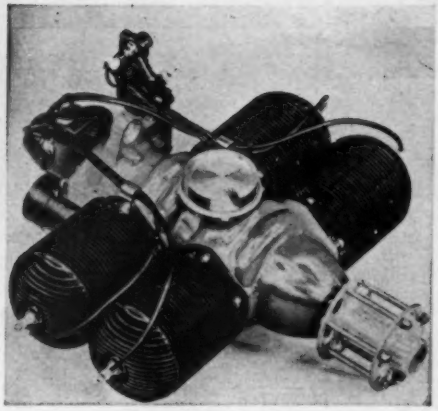


Twin Engines? Look Again! The "two-engine" Navy patrol bomber above—the new Martin XP4M-1—really has four power plants to zoom her upward. Allison jets, providing 4,000 pounds of thrust apiece, are mounted (inset) directly behind each regular 3,000-hp. Pratt & Whitney engine. The plane cruises at 200 m.p.h., can do better than 350 m.p.h., and has a range of more than 3,000 miles.

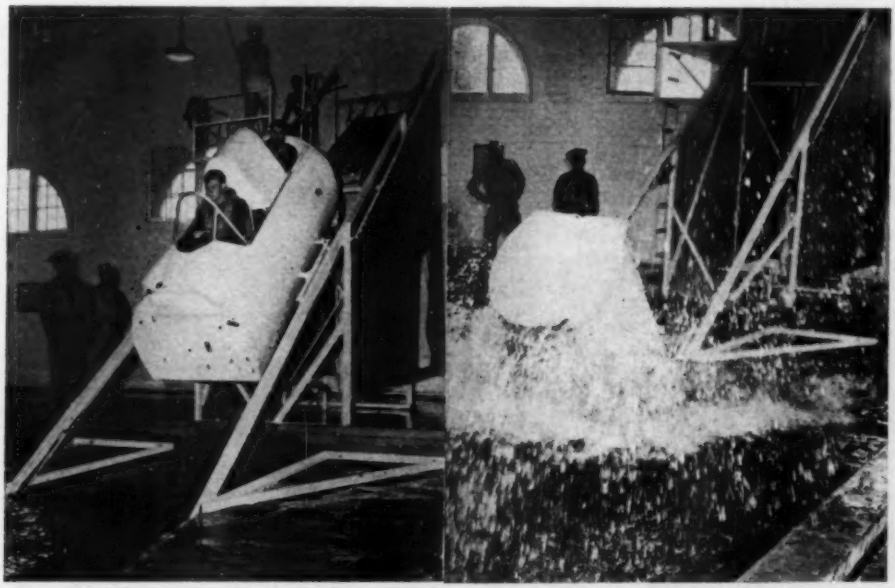
One-man Air Control Panel. This single panel has everything for air traffic control; if need be, one man can run it alone. Flight plans, flight conditions, instrument- and contact-flight records are all ready in the center of the AAF Control Tower Console, shown undergoing extensive tests at Langley Field, in Virginia.



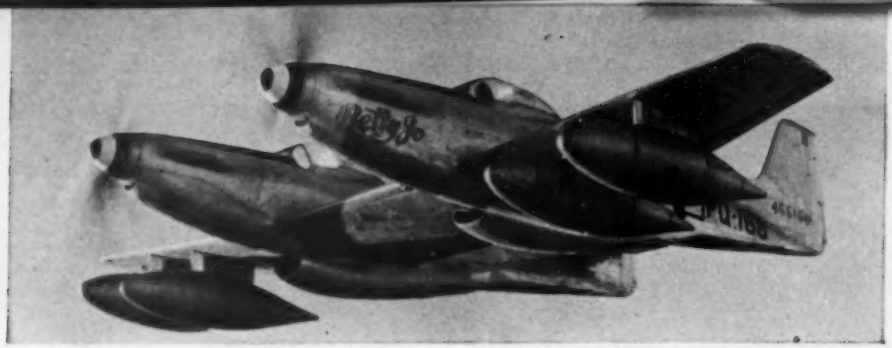
Panel Shows Fuel Flow. A pilot sees at a glance how much gas is going where with the fuel control panel used on Boeing Stratocruisers. Bottom dials show supply in each tank, lines mark fuel pipes, knobs control and indicate flow direction.



Baby Engine Speeds Targets. This McCulloch engine weighs only 74 lb., but its four cylinders produce 60 hp. to fly target aircraft at 200 m.p.h. It has no gears, all accessories being driven from the free end of the crankshaft.



Crash Landing in a Pool. Since Naval fliers always face the danger of a crash landing at sea, they are now being trained beforehand, in the safety of a swimming pool, to escape from their sinking plane. Picture at left shows a simulated cockpit, with pilot and gunner, about to hit the skids. At right the "Dilbert Dunker" crashes into the water. The men must now get out of their safety harness and free their emergency equipment—all in a few seconds while the cockpit is still in motion.



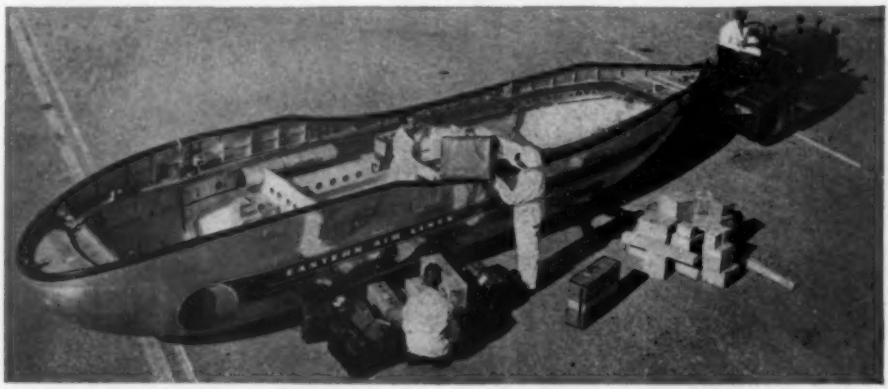
P-82 Sets Distance Record

WITH perilously little gas left in its tanks, an Army Air Forces P-82 twin Mustang swooped down on New York's La-Guardia Field on Feb. 28 to complete the longest nonstop flight ever made by a fighter plane. It had flown all the way from Honolulu—5,051 miles—in 14 hours and 33 minutes, averaging nearly 350 m.p.h.

The *Betty Jo* (named for the wife of its pilot, Lt. Col. Robert E. Thacker), made the record flight despite a severe handicap. It carried four auxiliary wing tanks, each holding 310 gallons, when it took off. Col. Thacker jettisoned the first one over the Pacific, but as the tank fell free, it damaged the trailing edge of the left wing. Col. Thacker and his co-pilot, Lt. John M. Ard, had to continue on to New York with the remaining three tanks still in place, despite the increased drag. The tanks are shown, above, during a trial flight.

The flight was not just an attempt to set another record. It had a definite purpose: to test the feasibility of extremely long-range fighter escorts for heavy bombers. The twin-fuselage plane carried special equipment designed to help pilots withstand the strain of such long flights. The seats were of a new pulsating type and the pilots wore a recently developed parachute harness.

The seven-ton plane, powered by two 12-cylinder liquid-cooled engines, carried its weight in gasoline to make the trip. For a time, it appeared that the *Betty Jo* would have to land short of its goal, but the tremendous fuel load proved just adequate to reach New York.



Air-Liner "Cargo Canoe"

THE gondola-shaped container above is to speed the loading and unloading of baggage and air express on Eastern Air Lines' new Constellations. It is loaded inside the air terminal, towed to a waiting plane, and hoisted to flight position on bottom of fuselage. Fully loaded, it weighs five tons—four of them pay load.

Whirling Atoms. A new "nuclear induction" machine may soon provide a faster, more practical method of chemical analysis. The substance to be analyzed is placed in a magnetic field, and the outer of two surrounding coils (inset) is charged with a high-frequency current. At a certain frequency, different for each element, the nuclear particles begin to spin up to 42,500,000 times a second, inducing a corresponding current in the inner coil. This frequency reveals the presence of an element.

Recording Rockets' Flight. To snatch valuable scientific and operating data from speeding rockets before they are dashed to destruction, General Electric has developed a telemetering unit that weighs only 15 pounds and transmits 28 items of information every 1/35 second. Ground equipment records the data permanently on film. Used in recent V-2 tests by the Army at White Sands, N. M., the rocket unit has only 10 tubes, is one-sixth the weight of previous comparable equipment. Shown at left (in box, bottom foreground), the set is being connected to an antenna for a ground test.

Mechanics of LIVING

How Men's Shoes Are Made

1. First step in the manufacture of shoes is the testing, sorting and selection of skins arriving from the tannery. (These pictures were taken at the Johnston and Murphy shoe factory in Newark, N. J.)

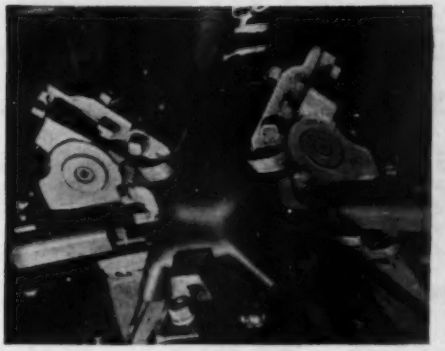
2. The tongues are stamped out on an automatic clicking machine, which also finishes them off with scalloped edges along the top. They are then stitched to the upper part of the shoe just below the laces.

3. Meanwhile, the vamp, tip and two side pieces, forming the upper body of the shoe, are cut out by hand along brass-rimmed patterns, making possible a more careful selection of cuts and matching of parts.

4. The eyeleting machine, handling up to 4,000 shoes a day, stamps out two rows of metal-rimmed perforations for the laces. On some shoes, the eyelets are attached on the inside and cannot be seen.

5. Silk threads are used for permanent stitching of the upper parts of the shoe, which are first cemented together to insure perfect alignment. Only the center portion of the hide is used for these parts.

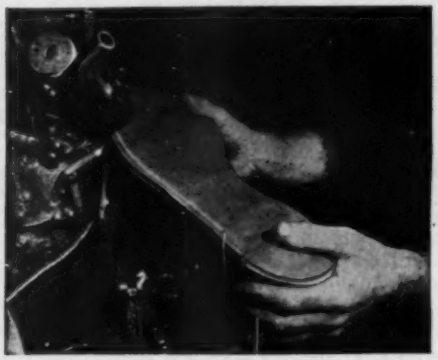
6. The side-lasting machine pulls the upper part of the shoe down tight over the wooden form, known as a last, around which the shoe is molded. The shoe is then stapled to the last with small metal tacks.



7. In the jaws of the bed-lasting machine, the front and rear portions of the shoe are pulled tight, while another part of the mechanism feeds out wire and secures ends of leather at the front of the shoe.

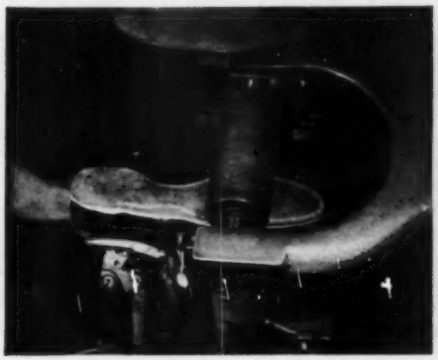
8. To form a foundation for the bottom of the shoe, a welt, or leather strip, is sewed around the rim of the shoe with a wax-coated thread. A steel shank is then inserted to form a firm support for the arch.

9. Of the 49 main operations, one of the most important is the rounding of the sole. This is done on another automatic machine that trims the excess from its edges and determines its final shape.



10. The sole, cut from the tough kidney portion of South American steer hides, is first cemented and then sewed onto the bottom of the shoe with a fine linen thread that can withstand a pull of 58 pounds.

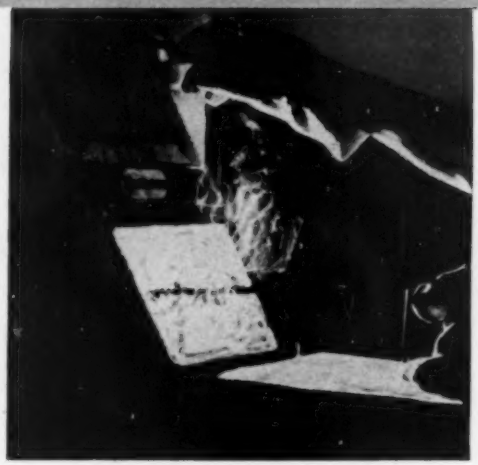
11. A leveling machine, exerting 450 pounds of pressure, smooths the sole into position and insures a proper fit on the bottom of the shoe. It takes a month to six weeks to complete a pair of shoes.



12. On the heeling machine, final step in the process, an automatic nailing mechanism fastens on the heel. Waxed, washed, and polished, the finished shoes, with laces added, are now ready for boxing.

Carrying the Ball for

Today's research teams speed creation of new products.



SCIENTISTS play on teams these days. The corny tintype of the long-haired fellow who locks himself into his bleak garret laboratory and emerges with a long beard and a great discovery is as remote from present-day research as the alchemist.

Your searching scientist no longer snoops alone. He can't. The fields of science have grown far too complex and numerous for any one man to cover. It takes a team of experts to tackle a problem of industry.

The modern physicist working on a problem in electronics, for example, no longer can depend entirely on his own knowledge and know-how. In the modern laboratory he can tap the specialized knowledge of chemists, microscopists, glass blowers, metallurgists, engineers, and, in the end, skilled modelmakers, to give his idea the flesh and blood of metal, wires, and glass that make it a reality. As many as a dozen highly trained technicians may have their fingers in even a small industrial pie. A major development may require co-operation among scientists in a single laboratory, collaboration among laboratories within an industry, and, sometimes, teamwork between industries—and nations.

More than 2,000 British and American technologists worked elbow to elbow at M. I. T.'s Radiation Laboratory, for instance, to give us radar and such related devices as Loran and Shoran. All along the line, it was a pooling of scientific brains that gave us the weapons that were our margin of victory.

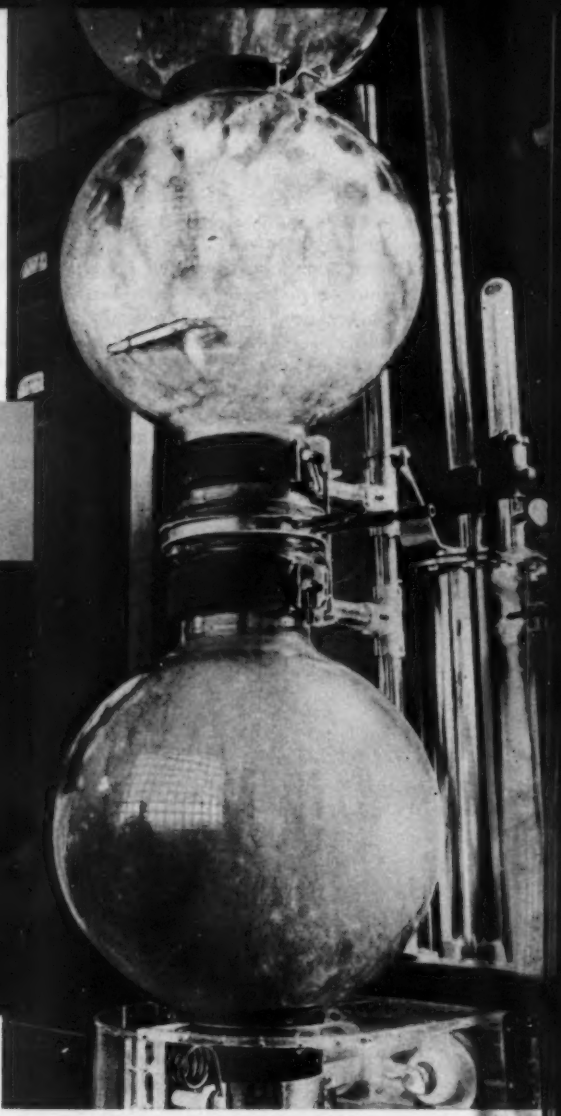
A good example of present-day teamwork in research is the work being done in the development of the gas turbine-jet propulsion engine (PSM, Dec. '45, p. 76). While turbine experts in one industry have been battling with design and mechanical problems, metallurgists in the metal industry have been busy devising new and better turbine-blade alloys, tough enough to stand up under the terrific heat of the turbine's exploding gases. Petroleum chemists, meanwhile, have been seeking the ideal gas-turbine fuel, as well as a bearing lubricant that will continue to work when a turbine's shaft

Teamwork does not stop for lunch: The RCA Laboratories' cafeteria provides a congenial forum for busy scientists who seldom have the chance to confer elsewhere. At left (l. to r.) are Igor E. Grosdoff, in charge of research on the electronic counter; Wendell L. Carlson, who directs radio-receiver research; Dr. Albert Rose, who guided the development of the Image Orthicon tube for television; and Dr. Irving Wolff, specialist in radar.

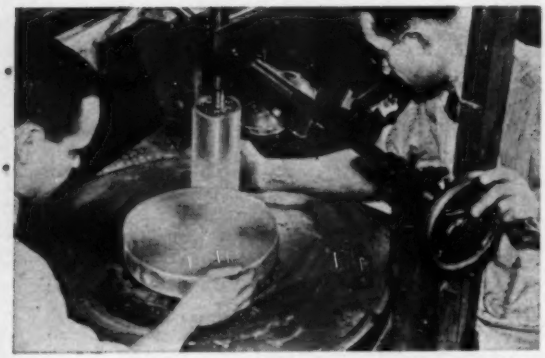
PSM photos by W. W. MORRIS

NEWEST TOOLS aid the scientist in the modern research laboratory. Right, a radio-heat dehydrator.

SCIENCE



METALLURGISTS are important on research teams. Here, one of RCA's opens a hydrogen furnace.

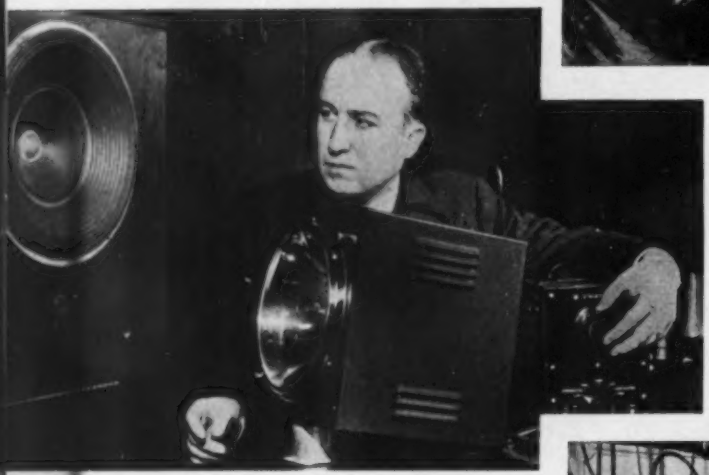


OPTICAL EXPERTS, left, help solve a television problem by grinding a special 12-inch mirror.

spins at speeds of 15,000 r.p.m. and more. At the same time, experts in other industries are thinking about ways of putting this new power source to work in airplanes, boats, locomotives, trucks and buses.

The physical aspects of the modern industrial laboratory make this speed-up in scientific developments possible. First of all, it is not one laboratory but a group of laboratories housed in one or more roomy, well-lighted buildings, generally set apart

from any of the company's manufacturing activities. Take a walk through a typical research factory—the new RCA Laboratory at Princeton, N. J., and you would see not just a radio laboratory, but electronics, acoustics, chemistry, physics, mechanics, and optics laboratories, plus a modelmaking shop, a photographer's department, a library, a glass-blowing shop, and, last but far from least, a cafeteria where the scientists and their workers can relax, and eat. A restaurant plays an important part in the modern research center. Scientists like to talk about their problems while they eat. Many a research nut has been cracked over coffee or cokes, with scribblings on



GLASS BLOWERS are a necessary part of the RCA Laboratory team. Like the craftsman shown above, they blow new tube ideas into reality.

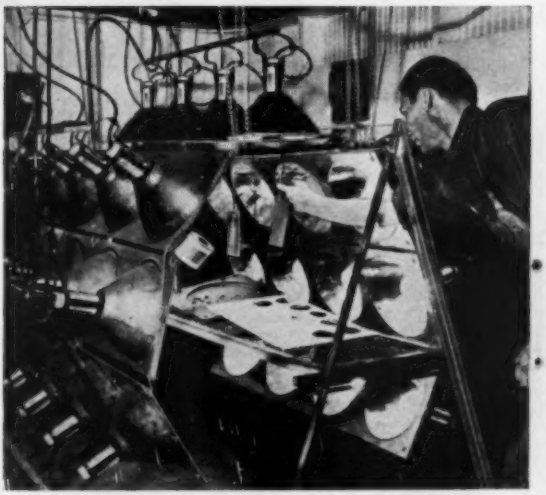
ACOUSTICS ENGINEERS tackle the problems that arise in radio design and development. At left, an RCA expert uses a stop-motion stroboscope to check on the performance of a loudspeaker.

a paper napkin the proof of the solution.

A research project is born in any one of a number of ways. It may originate in a scientist's mind or at the suggestion of some laboratory helper who runs across an odd fact or curious reaction in his work. It may come as a specific request from an industry, which senses something that you want and need.

Not long ago, the Committee on Sensory Devices of the National Academy of Sciences came to the RCA Laboratory with a typical research problem. They wanted to develop a practical reading aid for the blind—a device as compact as the conventional hearing aid that would allow a blind person to "read" directly from a printed page.

The project's first stop on the RCA idea-assembly line was the desk of L. E. Flory, one of the team of scientists who perfected



MODELMAKERS, working with modern equipment like this infrared drying rack, can turn out just about anything that scientists need in their research.

the "sniperscope" and "snooperscope," used so successfully by our troops in the Pacific (PSM, June '46, p. 73). Flory's first step was to find out what had been done along the same lines by other inventors in the past. Searching through old records he found that an electrical device employing five separate light beams, which transformed the light and dark areas of printed letters into tones that could be heard and "read" by a blind person wearing earphones, had been developed in 1914 by a Frenchman named Fournier D'Albe. It was complicated, however, and could not be adapted to type of varying size.

But here was a starting point. Flory and other RCA scientists, including experts in television, optics, radio and sound, went to work. During the course of their experiments they needed advice on plastics, on batteries, and on the physiology of hearing.

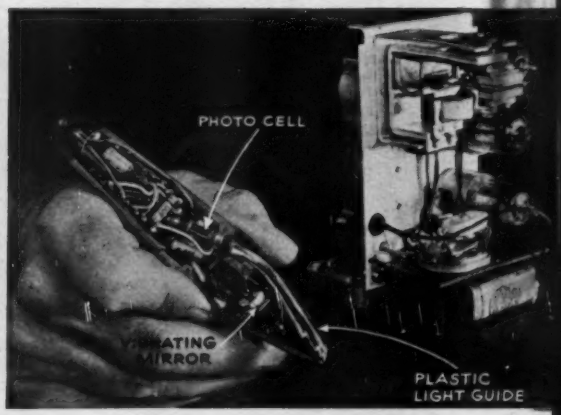
The project was started a year and a half ago. Today, thanks to research teamwork, Flory and his associates have an experimental model of a reading device that they hope *may* be the answer. It is now being tested by blind subjects. It may be a long time before it or some similar device will be available on the market, but a practical scientific approach has been set up.

Hundreds of such individual research projects have been speeded up and made possible by teamwork research. At present, there are more than 133,000 workers engaged in industrial research—90 percent more than in 1940—and there are more than 2,400 industrial laboratories.

The era of assembly-line research is just beginning. The lone scientist will still be responsible for each original idea, but it takes a team of experts to provide the varied and specialized knowledge, and that friction of minds working together, which speeds ideas toward reality. END

How Research Teamwork Works

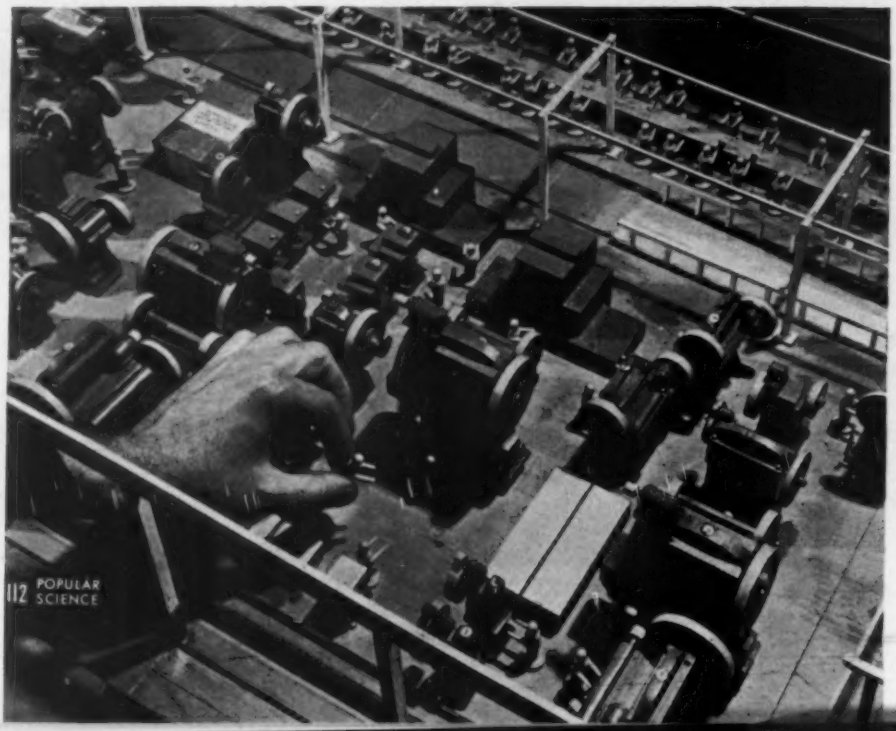
Here is an experimental aid for the blind that research teamwork at RCA is helping to make a reality. Basically, the device is a miniature, mechanical television camera, in a small stylus that can be moved along a printed line. A tiny vibrating mirror causes a spot of light to scan the letters as the stylus is moved. Light reflected from the light and dark areas of the letters is picked up by a rod, which guides it to a peanut-size photoelectric tube. The phototube controls an audio-oscillator, which transforms the reflected light into a warble that can be heard in earphones, and thus can be "read" by a trained listener.



Leg Rests Built into Coach Seats. There's not only room but a place to put your feet up in the Great Northern's new day coaches. A rack drops down from the back of the seat ahead. The seats also swivel around to face the windows or the car's rear. The new coaches are used on the streamliner Empire Builder.

Lenses Help Television. The correcting lens, at right, undergoing inspection after polishing, removes aberrations after a mirror has enlarged a television image to five times the prewar size. The American Optical Co. makes both mirrors and lenses.

Miniature Assembly Line. Ford engineers see a new plant in three dimensions long before the ground is broken. They put their model makers to work and view the plant scaled ¼ inch to the foot. Below, a worker is placed near a "giant" press.

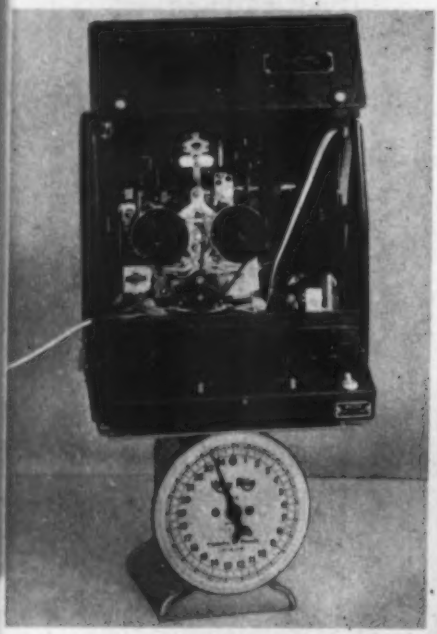


PIN-UP

REPUBLIC SEABEE. An all-metal, four-place amphibian, the Seabee has a top speed of 120, cruises at 105, takes off in 300 feet on land. Its pusher propeller, set above and behind the cabin, is driven by a 215-HP., air-cooled Franklin engine.

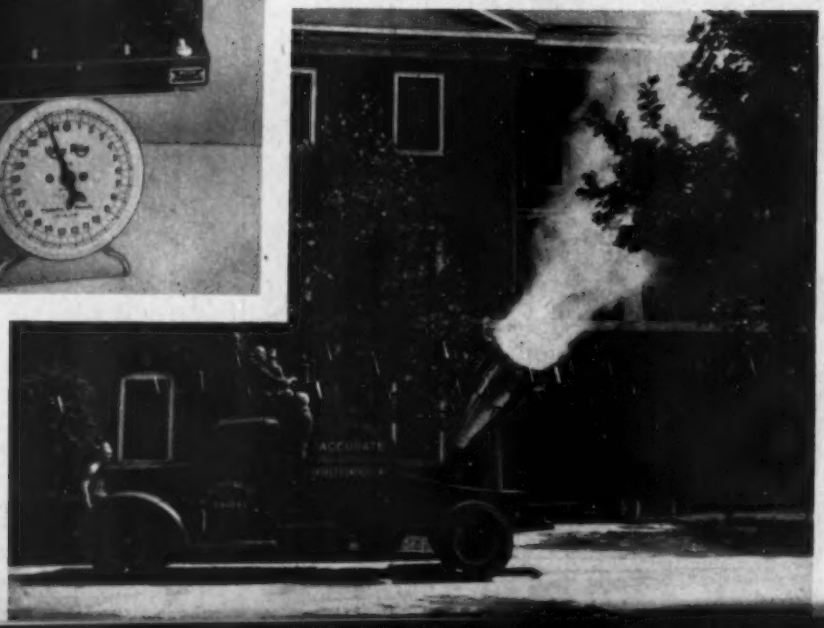
Huge Bell Jar Aids Research. Built by the AAF for high-altitude tests, the plastic bell jar above is believed to be the largest ever used for research. Six feet high, it resists 12-ton pressures.

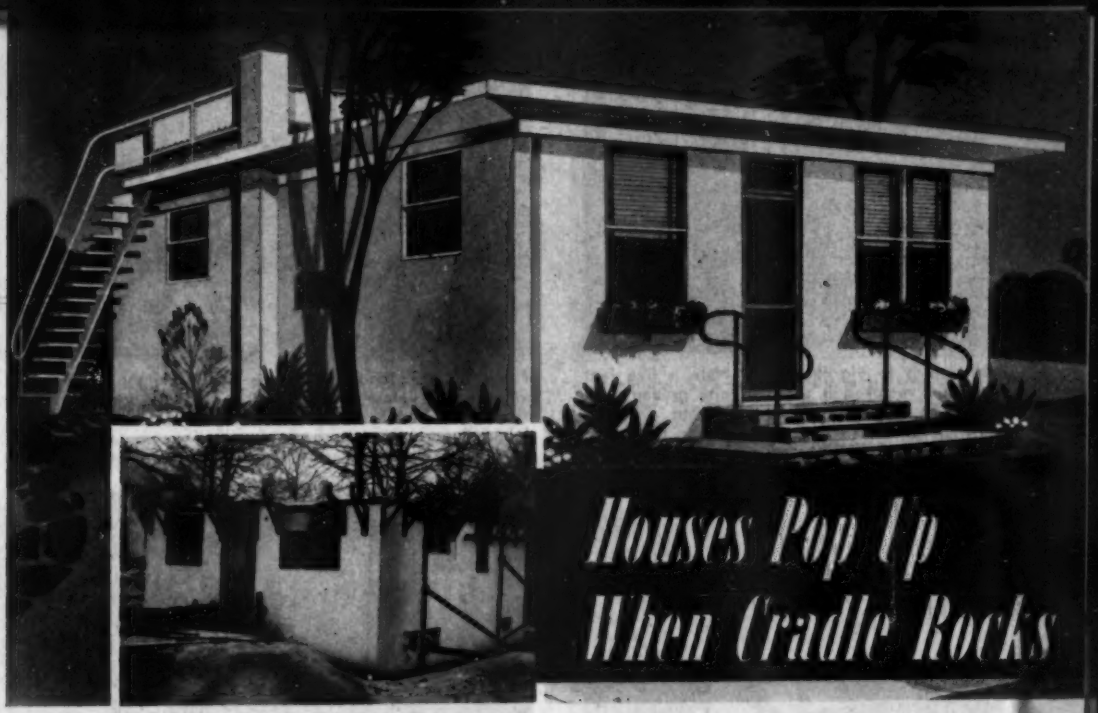
It Magnifies Mistakes. The giant teeth shown by this Ford "comparator," used to test precision gauges, are really magnified shadows of screw threads in the gauge visible below the screen.



Teletype Goes Aloft. To provide printed communications for aircraft in flight, Bell Telephone technicians developed the teletype printer at left. The printer itself weighs less than 24 pounds, and a complete airborne installation adds only about 35 pounds to a plane's load.

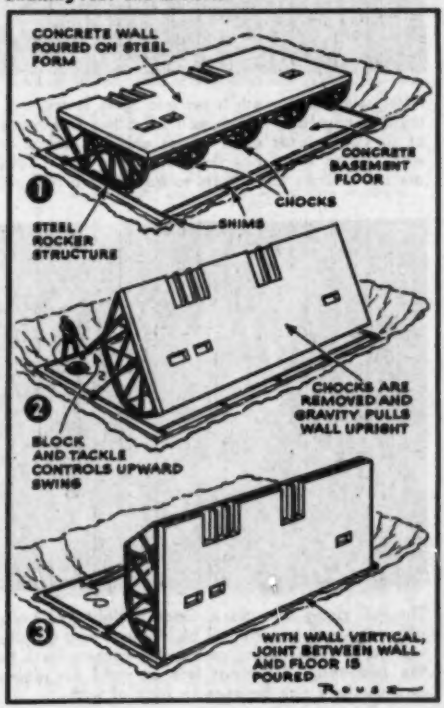
Motorized Spray Gun. For insect control in large areas, the truck shown below carries a swivel-mounted aircraft engine and propeller. Insecticide fed into the propeller's blast is spread hundreds of feet in any direction.





Houses Pop Up When Cradle Rocks

Drawing above shows how experimental Tyrocrete house, in New York City, will look when finished. Inset shows the structure partially completed, awaiting roof and interior.



By HARTLEY E. HOWE

YOUR new house may be built in a cradle and rocked into place. That's the latest method of mass-producing concrete houses, developed by Charles Tyroler, New York engineer, to help solve the housing shortage.

For an ordinary concrete house, complicated forms must be built or fitted together at the site, or expensive machinery is needed to transport precast walls and lift them into place. Tyroler's "Tyrocrete" method entails pouring the walls flat, in simple open forms laid on top of steel rockers. These are unbalanced by the weight of the concrete so that gravity pulls each wall up into position.

Concrete, Tyroler points out, is not only permanent, fireproof, waterproof and insectproof, but is obtainable almost everywhere. The Peerless Construction Company, of New York, plans to have the rocker forms built locally and either sold or rented to contractors. It estimates that only 100 houses need to be built to pay for a set of rockers. Since no special training is required, local labor can be used entirely. Savings over more conventional methods are estimated to run as high as 50 percent.

The Tyrocrete method can be used for any style of house, although the walls naturally cannot be higher than the width of the cellar on which the rocker rests. The experimental house shown here has five rooms and full basement, will probably cost under $10,000 with lot.

First step is to dig the cellar. Hole is five feet deep; dirt removed is used to raise ground level around house by two feet, improving drainage and permitting seven-foot basement. In the South, the cellar can be eliminated, saving about $1,500.

Forms for walls and footing are colored to show which side of house they belong on. Tyrocrete system is planned to require a minimum of skilled labor. Supervisor works from manual. The ground layout must be exact so that walls will fit together.

Assembling rockers, which come in sections, usually takes a day. The two-foot metal wall forms are bolted flat across rockers, covered with form oil to keep them from sticking to concrete. Rockers must be accurately set so that wall lands on base.

After reinforcing mesh is set into open forms, concrete is poured on. Each wall takes two truckloads of six cubic yards each. Molds are flat for cellar wall, ribbed every two feet for upper wall. Bolts are set in forms to tie them to walls during rocking.

When all is ready, the tackle that keeps the rockers horizontal is loosened and gravity pulls the wall over to the vertical. One man can control the operation, which takes about a minute. Set-in bolts for roof can be seen along upper edge of wall.

The wall rising into place. Once upright, the bolts attaching wall to form will be loosened and gravity will go to work again, pulling the rockers back to the horizontal. Openings left in mold for doors and windows can be seen in face of wall.

Setting up forms for the footing and cellar floor. Footing has trough slightly wider than wall, set with metal shims. When wall's foot rocks into the trough, shims support it so that a narrow opening is left between wall and footing.

Spreading concrete over metal reinforcing of 4½-inch floor of cellar, strong enough to support rockers. Cellar floor takes four truckloads of six cubic yards of concrete each. Bolts are set into floor for the control tackle.

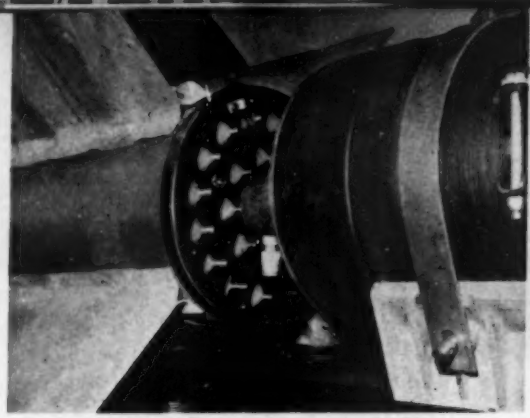
Concrete in forms is smoothed by hand, providing opportunity to give any desired texture. Beams can be set in for old English style, special doorways and pilasters used for colonial, rough stucco finish left for Spanish, block lines used for modern.

During 48-hour curing of 48,000-pound wall, workmen prepare footings. Space between wall and footing will be filled with caulking, covered with cement. Bolts to tie in floors and roof have already been put in molds so that they are set in walls.

When one wall is up, the rocker is partially disassembled and swung around to prepare the next. Here a second wall, at right angles to the first, is ready to rock into place. Upper wall channels allow for pipes and wiring, provide insulation.

Two walls in place. Corner seam will be made watertight with impregnated fabric, packed with oakum and covered with caulking. Meanwhile, temporary trusses hold walls and support metal forms for casting roof and floor.

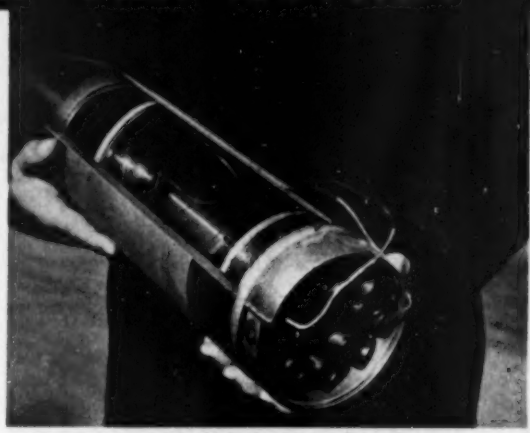
1. Tiny Tim is groomed for a railroad take-off. Its booster, or auxiliary motor, is nearest the camera. Metal roof protects track from heat of desert sun.



2. A view of the rocket's base. Booster, on the right, is a duplicate of rocket's own motor; it is dropped after 1,000 feet, when rocket motor ignites.

LOOK OUT FOR THE ROCKET

With a new automatic revolving launcher, these twin tubes in a plane's nose fire a whole salvo of five-inch spinner rockets in a matter of seconds.



Cutaway of spinner rocket shows angled ports that make it whirl. Rockets are fired from two motor-driven drums, which can be reloaded during flight.

Biggest U. S. artillery rocket built for aircraft launching is Big Dick, shown below in a ground test. It is 14 inches in diameter, 150 inches long.

Closeup of Big Dick's nozzle plate shows multiple ports through which burning gas escapes. Electrical contacts are in position, ready for firing.

3. Manganese steel grips hold the one-ton projectile to the track. After leaving its 1,500-foot rail, the rocket flies another 500 feet true to the target.

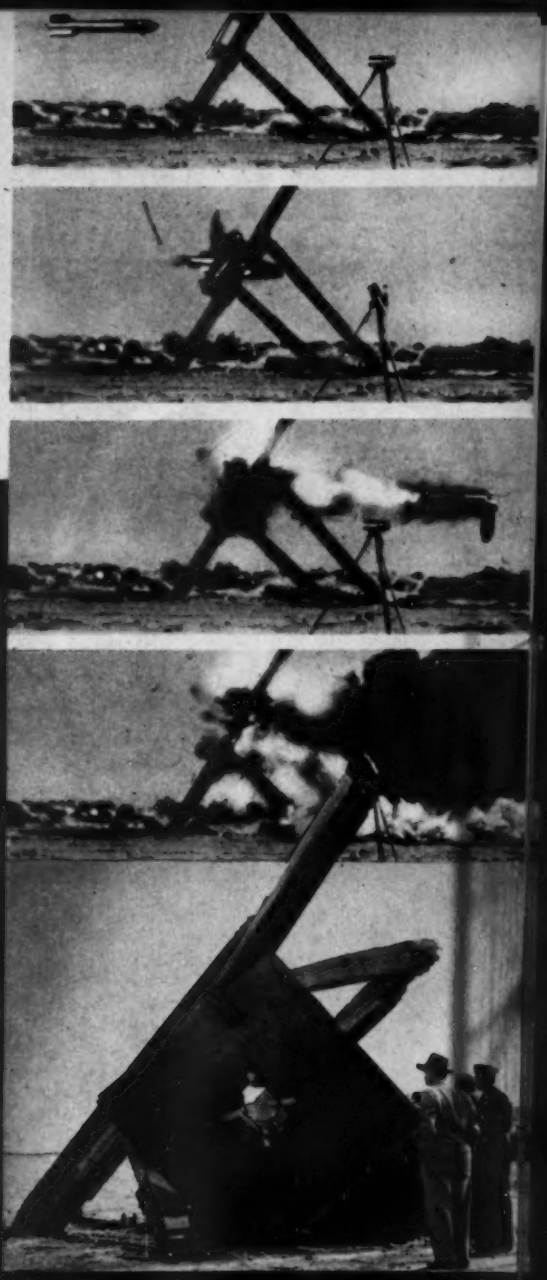
EXPRESS!

ON THE 1,000-square-mile desert range of the Naval Ordnance Test Station at Inyokern, Calif., rockets are undergoing exhaustive—and spectacular—tests designed to improve their hitting power and destructive force.

From the rockets' fiery performance before high-speed cameras and other precision instruments, Navy scientists learn not only how to make existing types more powerful, but how to design new ones and how to devise new ways of using them.

Two recent developments are shown here, along with a pictorial record of one of the tests, in which a Tiny Tim rocket takes a ride on a railroad to start a 1,000-m.p.h. dash before the camera.

Big Dick on the wing in a low-altitude test. The rocket attains a speed of 1,000 feet a second and holds 250 pounds of TNT—enough to sink a ship.



4. The four top photographs, taken at intervals of about 2/1,000 second, show the rocket approaching the target, penetrating it, passing beyond it (with war head broken off and dangling vertically from rocket's body), and exploding. The bottom picture shows what the impact of such a projectile, traveling 1,500 feet a second, can do to the target even without an explosion. The target, pierced and virtually demolished, is 2½-inch steel armor plate.

Souped-up Darkroom Runs Itself

15 seconds after photo is snapped it's on the screen.

FIFTEEN seconds after the camera above snaps your picture you're looking at yourself on the screen, larger than life. The involved processes of development and projection have been carried out automatically in the time it took you to hang up your hat and coat.

Eastman Kodak developed the machine secretly for such wartime jobs as projecting radar pips a few seconds after they flickered across a 'scope. Now it is being adapted for science and industry. Possible uses include recording oscillograph screens and spectroscopic analyses.

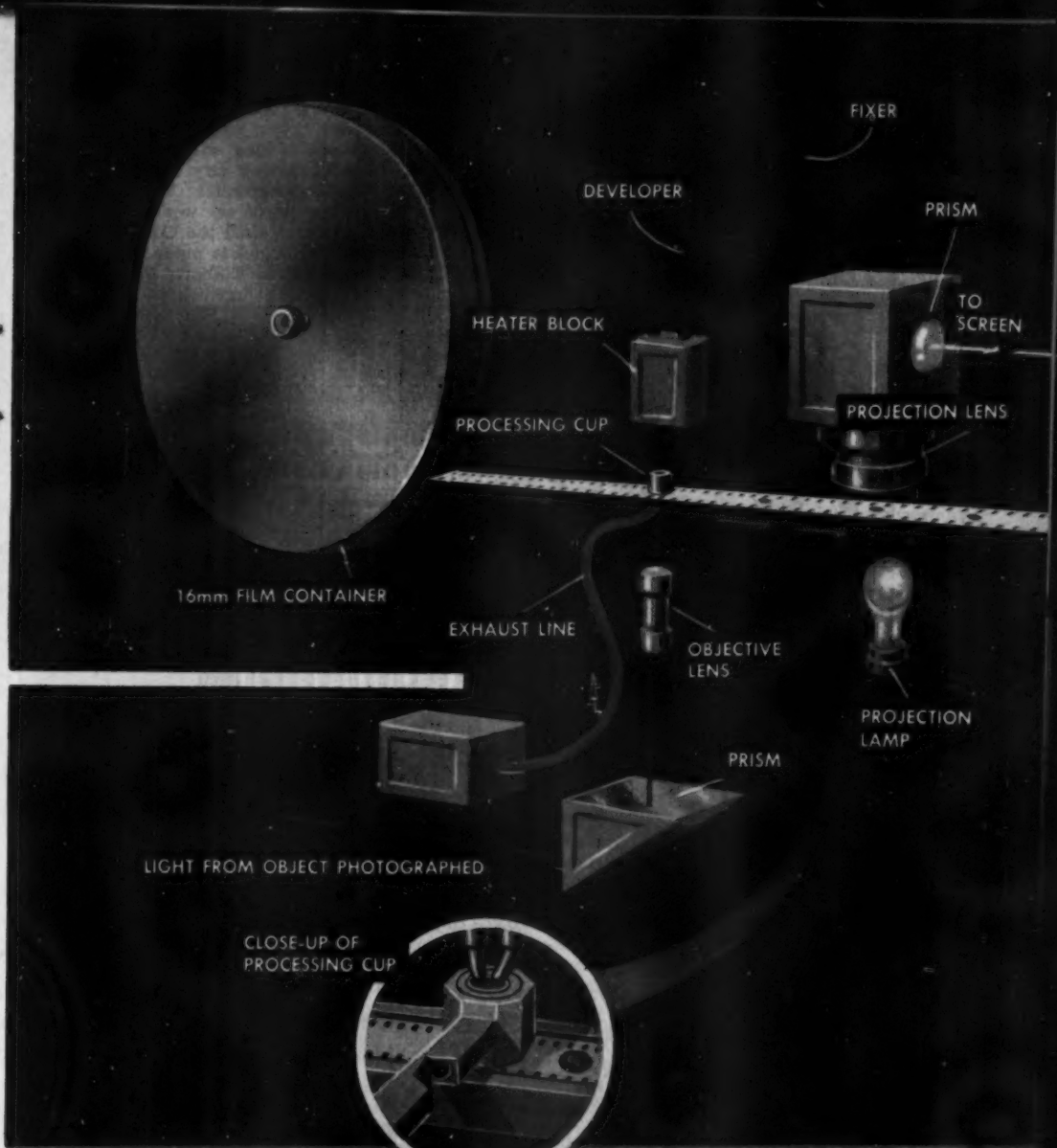
The machine's incredible speed results from the use of highly active chemicals—made even more so by preheating to 140°F. The developer—modified Kodak DS2—touches the film only four seconds. Fixing takes 6.5 seconds; washing, another second. The other 3.5 seconds are used for drying and moving the film.

Taking, processing and projecting the picture are a continual, automatic process, run by solenoids controlled by cam-operated switches. The 16-mm. film, emulsion side up, is pulled intermittently from a reel inside the light-tight camera. The image is thrown on it from below and development to a direct positive begins at once. No negative is made.

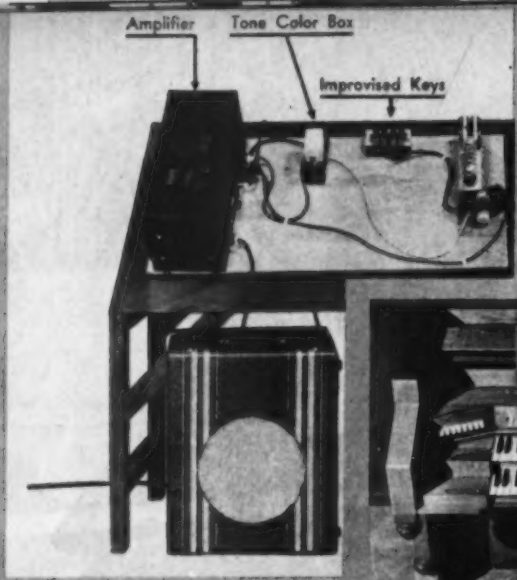
Developer and fixer are stored in tanks above the camera and fed through electrically heated lines to a tiny cup, open at both ends. This clamps down on the film at the exposure point, the smooth lower lip making a seal so that the film serves as the bottom of the developing "tank."

To prevent fogging the next exposure, residual hypo must be washed from the cup before the next cycle. Developer is used for this to avoid complicating the plumbing with another feed line. If a permanent record is desired, the film must be given additional treatment later.

After development, the image is advanced five frames into position for immediate projection. A 600-watt lamp shoots light up through the glass-bottomed film track. The f/3 projection lens is mounted vertically above the film and a right-angle prism bends the image beam to the horizontal toward the screen. Meanwhile, another picture is being made.



Simplified drawing above shows how processing machine, on opposite page, works. Arrows follow path of image from element lens. Inset shows details of processing cup, made of two concentric cylinders. Inner diameter is only ¼ inch, same size as image on film, and holds about .3 cc. of liquid. Clewlite nozzles feed in developer and hypo. Gateway below and raises and lowers cup, also is drain by which used chemicals are sucked away through the air space between cylinders. Same vacuum process dries film. At right, interior of the light-tight camera.



Tubes Replace Pipes. This compact organ can produce all the sounds of one with 1,333 pipes—without having any at all. The secret is in electronics: Vacuum-tube oscillators do the work of the usual pipes. Called the Connsonata, the new organ is made by C. G. Conn, Ltd., of Elkhart, Ind.

Simplified layout above shows how the Connsonata works. Pressing a key sets up electrical impulses, which go through a tone-color box to gain the characteristics of a desired stop, such as diapason or vox humana. After being amplified, the impulses emerge through the loudspeaker.

Electronics Gives That Beat. After 130 years, the old-fashioned metronome at left has a rival—the Metronoma. Clockwork and pendulum are replaced by a thyratron, or "heartbeat" tube, which produces an electrical impulse anywhere from 40 to 208 times a minute. The current activates a knocker and a neon tube, so that the beat can be seen as well as heard. The Metronoma is made by Crystal Research Laboratories, of Hartford, Conn.

Plastic Murals Are Painted with Light

By FRANK ROWSOME, JR.

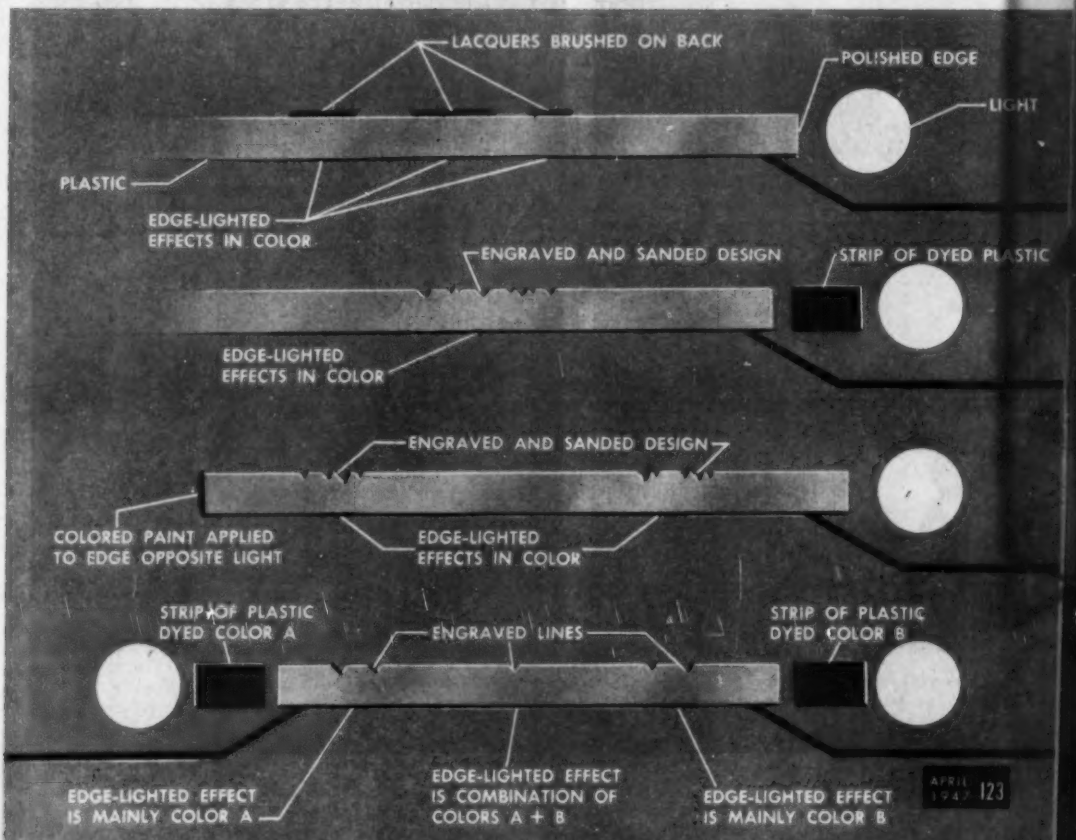
IF YOU take a sheet of clear plastic, buff the edges to a glasslike finish, and direct light into one edge, the sheet will conduct it much as a pipe carries water. No light will be visible on either face of the sheet, provided the source is shielded and the surfaces are unmarked. But if the surfaces are interrupted in any way, light will spill out at that point as from a leaky pipe. A deep V-shaped groove cut in the plastic produces a bright line of light; a thin scratch makes a delicate line; a few strokes of sandpaper cause a luminous cloud.

Because of this curious "light-piping" characteristic, the acrylic resins known as Plexiglas and Lucite—detoured during the war into such practical applications as bomber noses and fighter "greenhouses"—have emerged as dramatic new materials with which architects, designers and decorators are achieving startling illuminating effects never before possible.

The techniques behind these effects are new and changing, and the men who have developed them admit that much exploratory work remains to be done. It seems certain, though, that the next decade will see the spread of such things as murals that are literally painted in light, table tops and screens that spill a patterned glow from their surfaces, and entire walls that radiate softly to illuminate a room.

Actually, it isn't necessary to cut into the surface to make the light spill out. Anything that comes so close to the plastic as to break the "air seal"—the microscopically thin layer of air between the sheet and whatever is superficially touching it—will modify internal reflection, causing light to show wherever the air seal is broken. If you place your hand lightly against an edge-lighted panel and watch from the other side,

WAYS TO SECURE COLOR IN EDGE LIGHTING



First step in making the plastic mural shown on the opposite page, Designer Jane Perkins, of the Endicott Corp., makes a full-size freehand drawing on tracing paper, using decorator's sketch as a guide.

Next, the edges are polished on a sheet of plastic .187 inches thick, the protective paper is peeled off, and the sheet laid over the tracing on a light box. Then several lacquers are lightly brushed on.

[illegible] are then engraved with a high-speed flexible-shaft tool, using a steel burr. The tracing serves as a guide. A shaded fluorescent lamp at the top of the sheet partially edge-lights it for this step.

With a small piece of medium-coarse sandpaper, Miss Perkins sands the parts that are to appear as light-toned areas. The panel is placed upon black cloth so that the sanded areas can be easily seen.

Now almost finished, the plastic panel is inspected by Browning Marean, Jr., head of the Endicott Corp. Flaws of omission are easily corrected, but it is difficult to change what's already done.

After a final touching up, the panel is mounted in a shadow box (see page 126 for details of its construction) in front of another one painted a uniform blue color and also edge-lighted.

gradually increasing pressure against the panel, a point will occur at which this air seal is broken and the outline of your hand will appear in a ghostly glow. Paints and lacquers, or even strokes with a grease pencil, can be used as well as engraving and sanding to produce patterns of light.

This offers one way for designers of plastic murals to employ color. Lacquers can be brushed on the back of a panel, which will then spill light tinted according to the color applied in that area. A second color technique involves using opaque paint on the edge directly opposite the light source. Light then travels through the sheet, is reflected back by the painted edge, and emerges as colored light at the engraved lines. A third way to secure color is to interpose a strip of polished, dyed plastic between the light and the entering edge, a method that, like the second one, gives a single color everywhere light emerges.

Perhaps the trickiest coloring technique calls for the use of two lights and two dyed strips of different colors at opposite edges of the panel. As indicated schematically at the bottom of page 123, this results in a color blend that varies according to the relative distance of an engraved line from each dyed strip.

Depending on the purposes of the designer, various kinds of special backgrounds are used with edge-lighted sheets. The simplest consists of a panel of smooth-surfaced composition board, painted to harmonize with the design and mounted close behind the plastic. Another background uses a second plastic sheet that is sprayed or silk-screened to an even color. When this background panel is itself edge-lighted, a bright, luminous tone appears behind the main design to emphasize it or set it off. The use of several sheets of plastic in sandwich form gives endless chances for variation, including three-dimensional scenes and pictures in which parts of the whole can be made to appear or vanish at the flick of a switch.

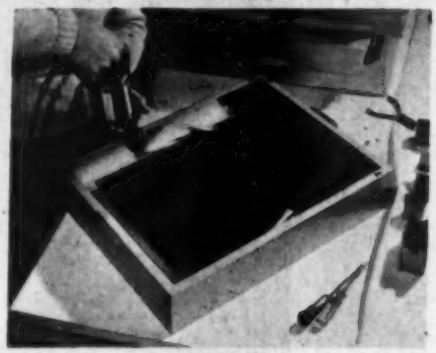
Experiments with edge-lighting show that the best light source is an incandescent bulb with a long filament. However, since very long bulbs of this kind aren't generally available, and since they generate considerable heat, fluorescent lamps are frequently used instead.

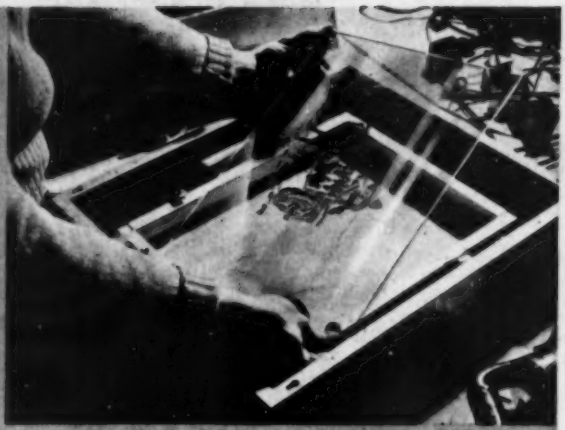
Certain special problems confront the designer of an edge-lighted plastic decoration. The acrylic resins have a fairly soft surface and must be handled with great care to escape scratching. (Scratches will of course edge-light as conspicuously as the design.) One advantage of luminous backgrounds is that they tend to drown out the minor scratches that occur almost inevitably in handling. This softness of the plastic also means that in such applications

as table tops, the plastic must have a protective pane of glass over it.

Another limitation springs from the fact that the total light available is necessarily limited—though it should be as bright as possible to avoid being blanketed by light from other sources. The light that can spill from any single engraved line is controlled by the intensity and distance of the light source, the thickness of the plastic (the thicker the better), the squareness of the entering edge, and, particularly, the amount of light that has been taken off the panel elsewhere. A deep V-cut that is half the total thickness of the sheet will approximately halve the amount of light available beyond it. This means that the design must be carefully contrived to deliver enough light to the heavy lines that need it and yet not starve other lines. END

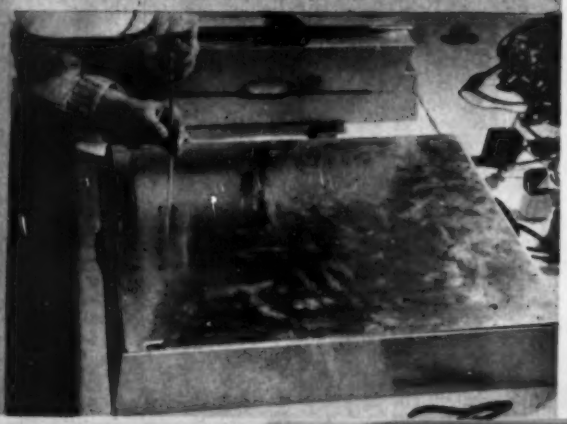
The shadow box, a rectangular sheet-metal casing, is used to display the mural in a hotel or restaurant. Below, holes are drilled through a template.





Two tubular incandescent bulbs are sufficient to edge-light the plastic sheet to go in this box. A clip is screwed to the internal lip, left above, so as to hold the socket in the same plane as the edge of the panel. Right, the engraved and painted plastic is slid into place, where it will be held snugly by several U-shaped clips. The engraved side must face to the back to have maximum brilliance of edge-lighting.

A background piece of colored glass fiber is inserted behind the plastic, below left, and the wiring to the two lamps installed. Final step in the assembly is to screw on a backing of sheet dural, right. The two slots at the ends of the shadow box, which are concealed when it is turned over, are to dissipate the heat created by the lamps. If ventilation were not provided, the temperature inside the box might build up to a degree high enough to harm the plastic.



Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish.

I'd like to see them make

Cartoons by SYD LANDI

Nose Warmer. It would be a lot more comfortable if earmuff makers added a puff for the nose, thinks Ann Lindhardt, of San Juan Pueblo, New Mexico.

Hair Catcher. An electrically charged plate for barbers that would make hair stand on end and attract all the clippings is the dream of H. W. Bull, of Midland, Mich.

Great Leveler. To place everyone on the same level while sipping sodas or eating hamburgers, Lloyd Griep, of Watertown, Wis., wants adjustable counter seats.

Firefly Print. For reading after sundown, Joseph Lee Coy, of Danville, Ky., would like to see books printed in ink that would "glow in the dark."

Hush-Hush Wrappers. Movies can be spoiled by the crackle of candy bars being unwrapped, so Eugene Anchese, of Dorchester, Mass., wants "silenced" wrappers.

Juice Trap. The eyes of the nation would be thankful for a dish with a guard to ward off squirts from grapefruit, says William Howie, of Longview, Wash.

COMBINE THAT PULLS ITSELF. This self-propelled McCormick-Deering harvester-thresher can be operated by one man when it is equipped with a grain tank or by two men when equipped, as shown, for bagging the grain. It is driven by a six-cylinder engine and has four speeds forward.

TRACTOR FITS IN ORCHARDS. A narrow tractor and offset disk harrow are combined for cultivating between the rows of orchards or vineyards. Plowing and harrowing are done in a single operation, and the two rows of disks leave a smooth surface.

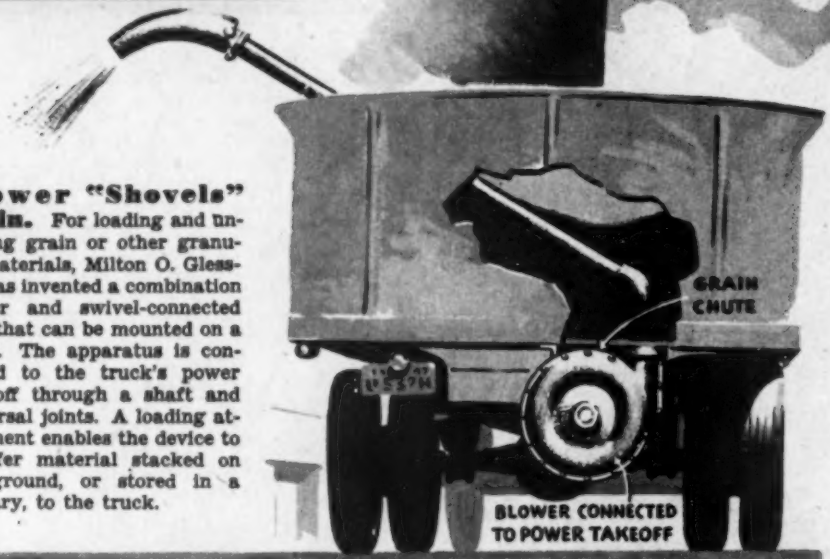
THREE-HULL BOAT

THRILLING speed and safety are combined in the tri-maran, modernized adaptation of primitive outrigger sailing craft of the South Seas. Designed by Victor Tchetchet, New York artist, the aquatic novelty rides on three floats, instead of the two of a conventional catamaran. Pontoons at each side of a canoelike center hull make the boat virtually noncapsizable. A pioneer 24-foot model, easily handled by one or two sailors, attains up to 22 miles an hour in a stiff breeze. Serving as a sailboat or a bathing raft, it accommodates 12 persons. Forty-footers are planned.

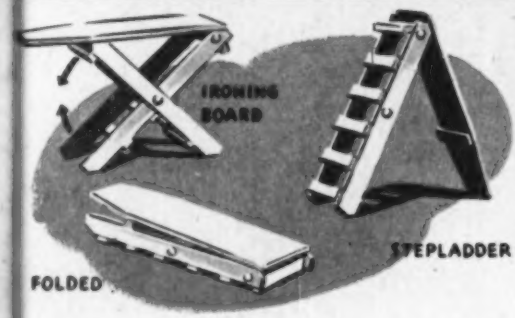
All of the family are safe aboard the tri-maran, above. This 24-foot, V-bottomed model carries 200 square feet of canvas. Light weight and shallow draft make it possible to beach the craft like a canoe after a sail.

Platforms astride the outriggers of the tri-maran, augmenting the passenger capacity of its center hull, serve as decks for sun-bathing or diving. A tiller extension to the outboard rudder permits the boat to be steered from the center hull or

NEW IDEAS from the INVENTORS

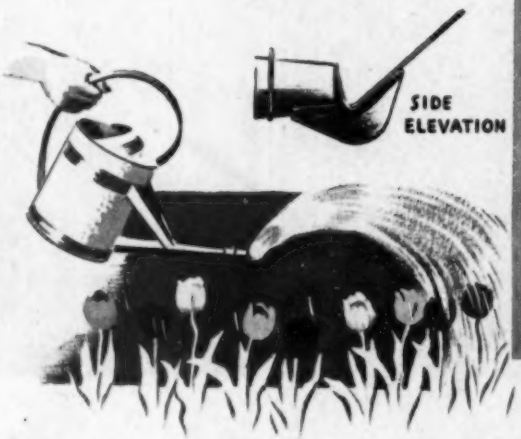


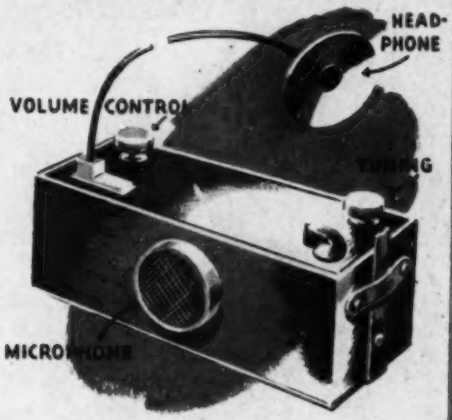
Blower "Shovels" Grain. For loading and unloading grain or other granular materials, Milton O. Glessner has invented a combination blower and swivel-connected tube that can be mounted on a truck. The apparatus is connected to the truck's power take-off through a shaft and universal joints. A loading attachment enables the device to transfer material stacked on the ground, or stored in a granary, to the truck.



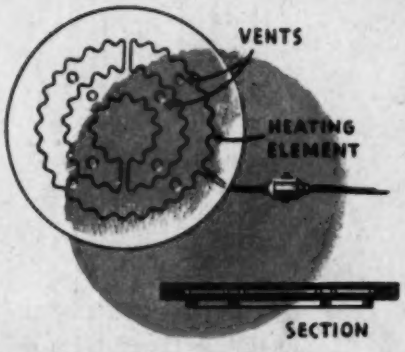
Ironing-Board Ladder. When the housewife isn't using the combination at the left as an ironing board, it can be converted into a sturdy stepladder by folding its legs and using the ironing surface as one of the ladder's supports. It can also be completely folded so that it takes up little room when put away. J. W. Mayhugh invented the device.

Nozzle Caresses Plants. A nozzle attachment for garden watering cans diffuses the flow of water into a light spray that covers a considerable area and will not harm delicate plants. The nozzle, invented by John Zvolanek, slips over the spout of an ordinary watering can. An angled plate, three times as wide as the can's spout, forces the water to spray upward. The nozzle can be turned to guide the spray in any desired direction.



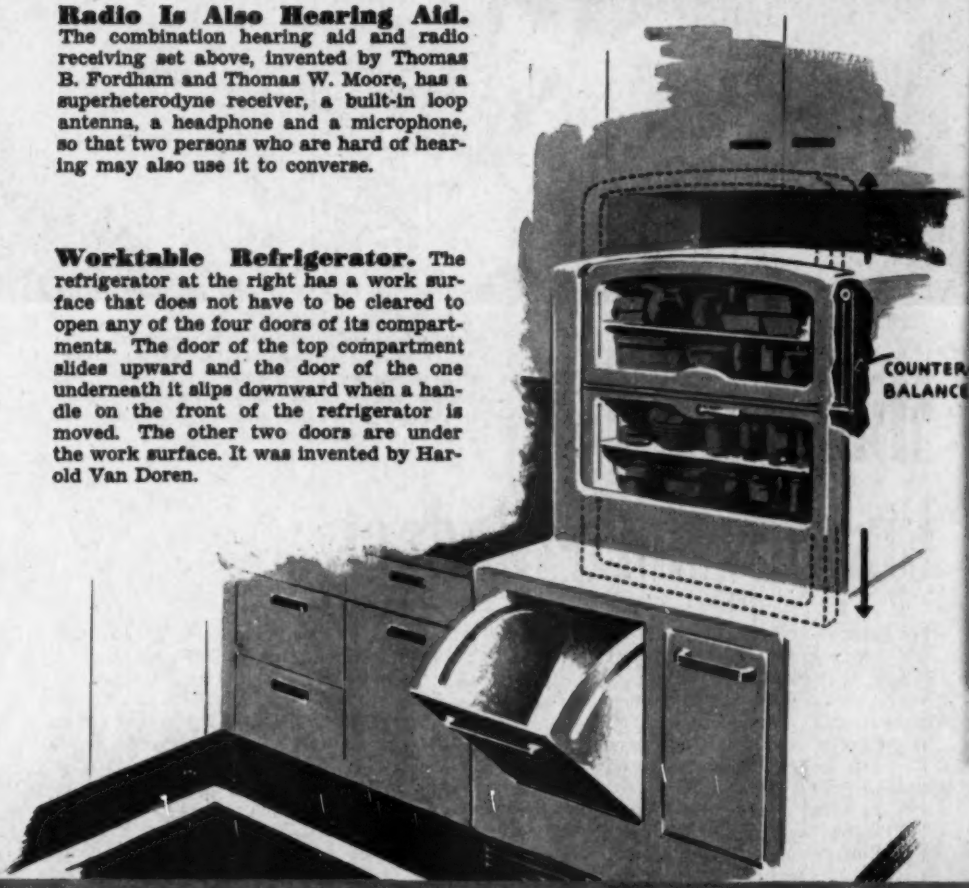


Radio Is Also Hearing Aid. The combination hearing aid and radio receiving set above, invented by Thomas B. Fordham and Thomas W. Moore, has a superheterodyne receiver, a built-in loop antenna, a headphone and a microphone, so that two persons who are hard of hearing may also use it to converse.



Hot Plate Made of Glass. By embedding circularly arranged wire coils in Pyrex glass, inventor John Bilan has devised a novel electric hot plate. The holes in the plate provide draft.

Worktable Refrigerator. The refrigerator at the right has a work surface that does not have to be cleared to open any of the four doors of its compartments. The door of the top compartment slides upward and the door of the one underneath it slips downward when a handle on the front of the refrigerator is moved. The other two doors are under the work surface. It was invented by Harold Van Doren.



According to historical research, this is how Fort Pitt, situated at the forks of the Allegheny and the Monongahela rivers, appeared in 1763. The buildings painted on the backdrop depict barracks for troops. The miniature-maker is putting a model horseman in position—one of many steps required in planning a particular scene.

Miniature Fort Guards Movie Budget

NOTHING spills dollars out of a movie producer's budget bag quicker than delays on the set after his cameramen have begun shooting the actual picture. So now, borrowing a practice increasingly favored by progressive industrialists, producer Cecil B. DeMille first builds his studio sets to scale in miniature so he can plot definite scenes, action and camera angles long before the cast and the technical staff for a picture go on the pay roll.

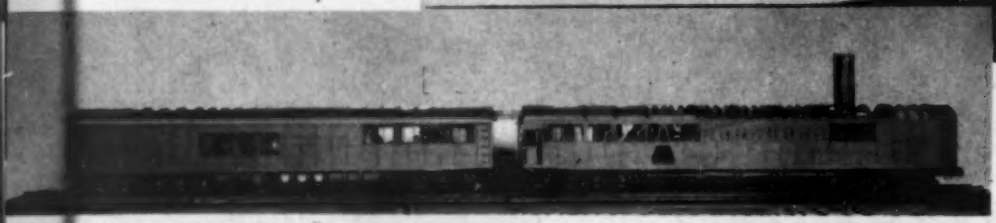
Recently DeMille had a scale-model, diminutive Fort Pitt built in Hollywood, and he studied it thoroughly before starting to film *Unconquered*. The model of the colonial fort's houses, fortifications and bridge was built 1/24 the size of the actual studio set. Its structures had removable parts that were lifted out for planning interior scenes and shots in the film's version of the 90-day siege of the fort in 1763, during the French and Indian War. Fort Pitt was built on the site of the modern city of Pittsburgh.

One of the scenes that cost less and came off more smoothly because it was first worked out with the aid of a miniature set is shown above. It pictures Seneca chief Guyasuta holding a white flag in his demand for surrender. The drawbridge in right background was built from the model in photo at right. Model is a reproduction of the counterbalanced drawbridge that protected Fort Pitt, constructed according to drafts found in the British Museum. Bridge's weight equals weight of a swing-down inner door. When door swings open, bridge is raised. A watch chain joins door and bridge in model.

At right: A craftsman lifts one of the removable walls of an inn, called the Gilded Beaver Tavern in the movie. In his left hand are tiny ale casks, one of the interior props used in the picture. Miniatures of goods that were traded to the Indians for furs are glued to the shelves. The come-apart construction reveals how almost any sort of camera shot can be studied. As *Unconquered* is in Technicolor, all parts of the miniature set were painted to resemble the full-size version. Even ocean-going ships and river boats appearing in the film were first mocked up in 1/24-size models. Below: An interior shot of the *Juvenn*, as it appears in the film.

MODELS Help Make Industry Tick

Modelmaker Chesebro working on his most complicated project, a scale model of a 10,000-kw. power plant mounted on two railroad cars. Scale was ½ inch to the foot. Below is the model, which Chesebro and an assistant worked on for 10 months. Car on left carries boilers to power huge turbine generators in car on right.



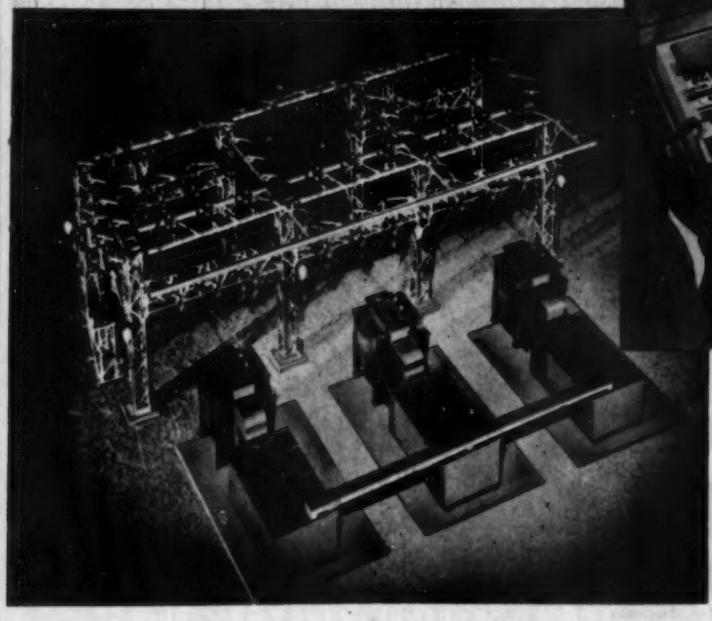
Setting a tiny valve in place on a turbine generator of the mobile power plant model. Built to supply emergency power for bombed-out cities, full-size mobile plant was never needed for original job but powered remote industrial installations.

HOWARD E. CHESEBRO'S job is a workshopper's dream: He makes exact scale models of everything from airports to appliance stores—and is paid for his fun. For Chesebro is General Electric's official modelmaker—and GE engineers have found that it saves time and money to have him turn their blueprints into three dimensions before building the real thing.

Chesebro's products range in scale from full size to 1/100 inch to the foot. His materials are equally varied: white pine for carvings, maple for wood turnings, brass and galvanized iron for structural members, white metal and aluminum for cast pieces. His outfit includes metal and wood lathes, sanders, circular saws, jointer planers, casting flasks—plus woodworkers' and machinists' finishing tools.

You'll find Chesebro any evening after work in a barn on his farm at Rotterdam, N. Y. But don't look for cows. The barn houses his home workshop. Chesebro spends his spare time making models.

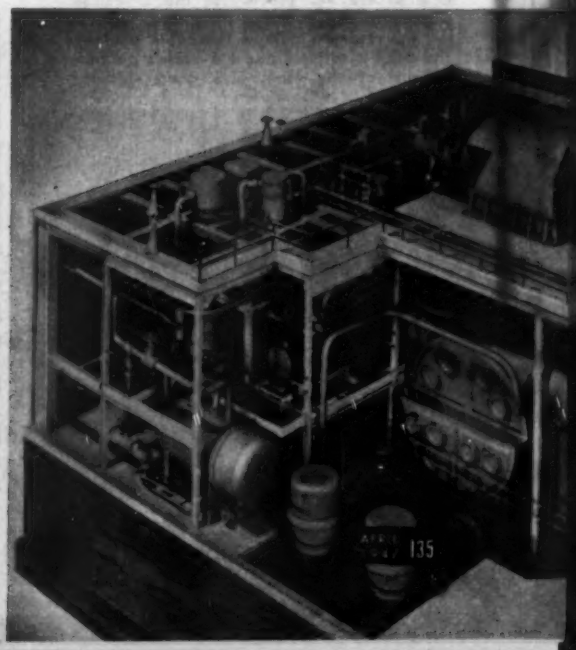
Into the suitcase at right is packed an entire electric substation—Chesebro size. GE builds the big ones and GE's salesmen carry the little ones in their sample cases to show prospective customers. The model comes apart for ease in packing.



At left is one of the miniature substations set up for display. The transformers and cabinets are made of wood; superstructure rigging and wiring, of brass. The full-size plant, used for multiple subtransmission systems, is a low-voltage selective substation, 9,000-11,700 KVA.

Chesebro was the first person to see what the GE jet engine, built for AAF fighter planes, would actually look like. His model, really a full-size replica (below), was built in secret; the engine parts were locked in a safe every night with the plans. Engine replica was one of Chesebro's favorite jobs in his quarter-century career.

The complicated model below is a turbine room, scaled ½ inch to the foot, built by GE for a large Eastern power company. Chesebro took four months to construct the model, which gave customer an exact picture of the proposed plant and a chance to correct errors in the design. Wood, brass, aluminum, lead and Plexiglas went into it.



5-PASSENGER PUSHER

A rear view of the new Cloudster discloses an unconventional tail construction, with a vertical stabilizer projecting below the fuselage, as well as one above it. The plane is 35 feet long, has a wing span of 40 feet.

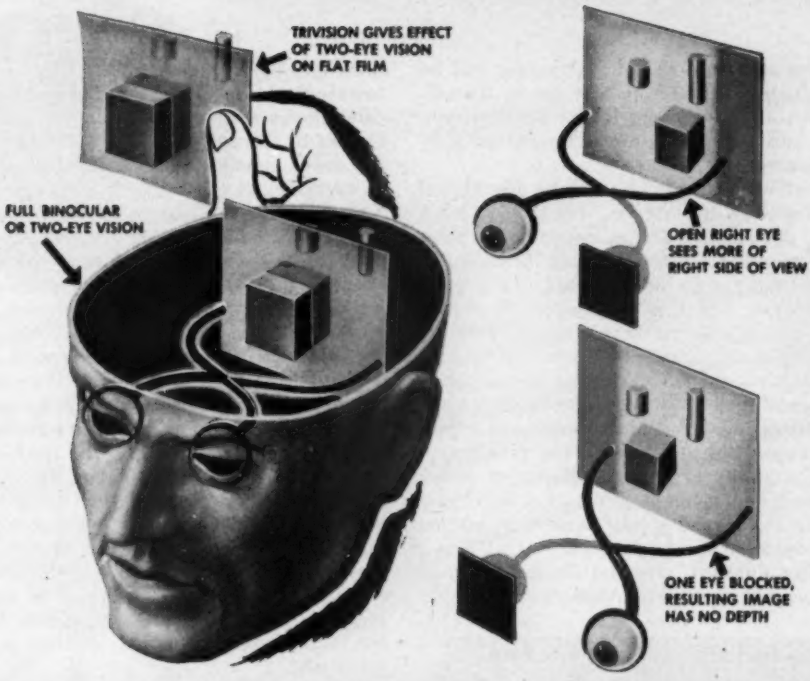
One of the two scoops for the air-cooled engines is visible in the wing root, just below the rearmost part of the cabin windows. The deep windshield and the cabin's position, forward of the wing, give good visibility.

TAKING the XB-42 Mixmaster as a partial pattern, Douglas Aircraft has produced an all-metal, five-passenger, propeller-in-the-tail airplane for executive use or for charter-operated service.

The Cloudster, as it is called, has two 250-hp. Continental engines housed inside the fuselage, and either or both can be used at will without departing from the center-line-thrust principle. Unlike the Mixmaster, which had counter-rotating propellers, the new plane has a single, eight-foot, two-bladed propeller.

With a service ceiling of 11,800 feet on one engine and 22,200 feet on both, the Cloudster carries its five passengers and 250 pounds of baggage 950 miles at 200 m.p.h. and has a maximum range exceeding 1,100 miles. The passenger compartment, forward of the low wing, affords extremely wide visibility; it seats two forward and three in the rear. The craft has retractable landing gear, with a steerable nose wheel for easy ground handling.

No price has been set for the plane, and Douglas says that no production plans will be made until it has completed an exhaustive flight-test program.



3rd Dimension Put Into Photos

By HERBERT JOHANSEN

RIDING to work on subway or bus some morning you're going to get the surprise of your life. You'll look up from your newspaper at an advertising card across the aisle. The familiar red-bandanna'd mammy—but her arms and the platter of golden-brown hotcakes she is holding will stick right out at you, so lifelike you'll be sure you can reach out and help yourself.

You will almost feel you can look around and see what's behind her. Without thinking, you will move your head to the left, and, by gosh, you can. That pitcher of syrup on the table wasn't there before. You will move your head back and the syrup pitcher will disappear behind mammy's ample form.

Blinking, and slightly befuddled, you will turn to another card, one showing a blond glamour gal sitting cross-legged in a chair, lipstick poised to her cupid's-bow mouth. Shapely legs will project provocatively. Her boudoir will appear to recede into space out beyond the wall of the car. You will hold back a whistle as you move your head from side to side this time. Then you will whistle, for right in front of your eyes the glamour gal will rub the ruby-red lipstick around her mouth.

Three-dimensional photography, produced on a single surface and seen without a viewing gadget, will be sensational in advertising art. But the new Trivision, with its revolutionary characteristics of "movement perspective" and the ability to "see around" an object, has much more important uses. Already it has proved its value in the production of X-ray and clinical photographs in depth and color (PSM, Sept. '42, p. 88). Three-dimensional aerial photography, when perfected, will be of vast military impor-

tance; as a training aid the process will be invaluable; Trivision movies are on the calendar, and, according to the inventor, you can look forward to three-dimensional television.

Just when the public will be introduced to Trivision, its inventor, Douglas F. Winnek, doesn't say. At the moment, the Navy has priority on the use of his three-dimensional patents under a nonexclusive license. But when Trivision is released to civilian life, you'll see that it has some pretty remarkable characteristics, including:

Depth to such a degree that one can place a pencil point on an object—such as the center of a flower—and the petals will appear to project out and beyond the pencil;

The ability to give the illusion of seeing around and behind objects—that is, objects in the foreground appear to move in relation to objects in the background;

The ability to give the illusion of actual movement in a still photograph.

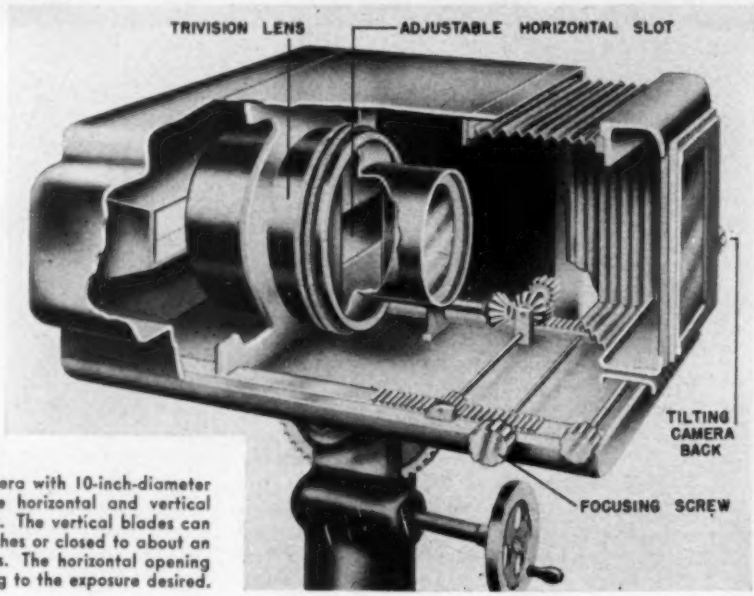
Navy Backing Speeded Perfection

Because of the military value of these characteristics of Trivision—plus its simplicity in requiring only one lens and one exposure—the Navy Photographic Service has been working with Winnek on his three-dimensional process for several years. Since 1945, complete Trivision experimental equipment has been under construction at the Aeronautical Photographic Experimental Laboratories at the Philadelphia Navy Yard. Thanks to this intensive war-born research and development, the process has outgrown its swaddling clothes with amazing rapidity. Now Trivision is about ready to make its commercial debut.

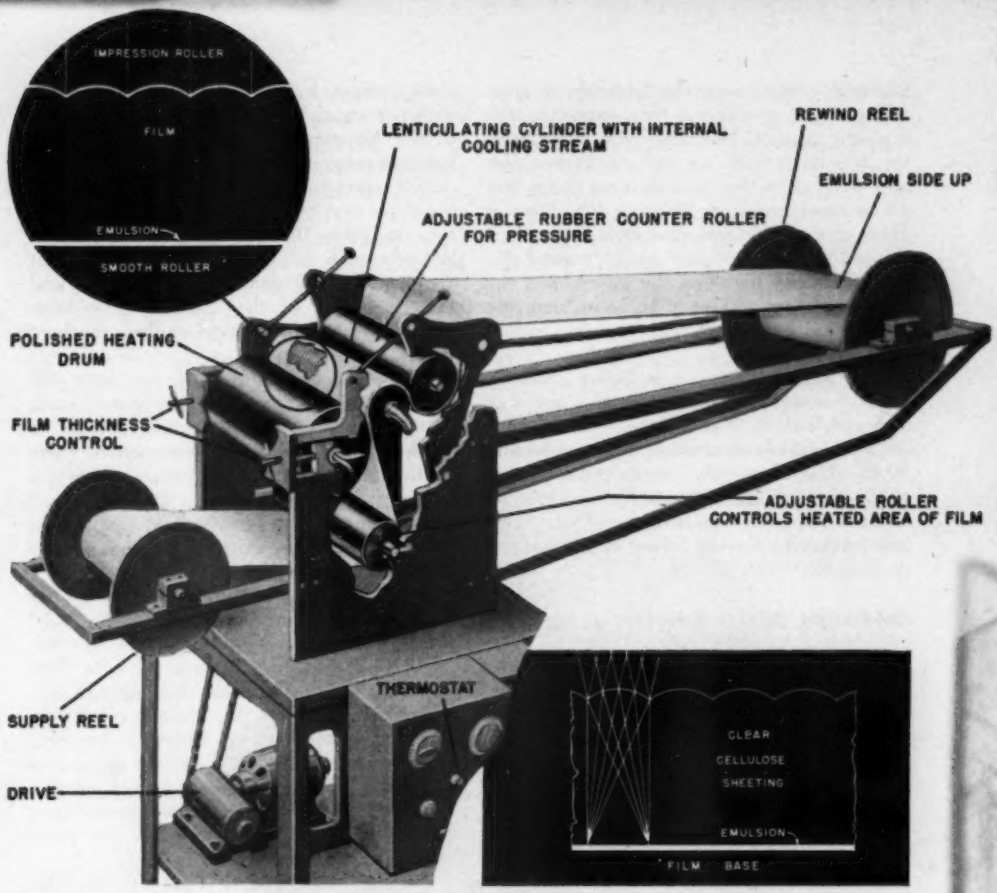
So, at 40, Douglas Winnek is within reach of the goal he set for himself 14 years ago. Although the Navy has given Trivision top priority on its photographic development program, and commercial enterprises are seeking licenses to his patents, Winnek, a self-educated man, calls himself a "goofy inventor." He is amused at being referred to in print as "a University of Rochester-trained optical engineer." He did study optics at Rochester—but he had to do it at night because he did not have a high school diploma. As a matter of fact, it was just recently that Winnek, on his way back from a trip to the West Coast, stopped off at the high school he attended in his native Madison, Wis., took some exams, and was finally graduated.

Winnek's process involves no new photographic principle in lens, camera or film processing. What is new is the film itself. Ordinary film does not pick up a three-dimensional image. Winnek's does.

It is ordinary black-and-white or color film—any standard emulsion can be used—



Cutaway of Trivision camera with 10-inch-diameter lens shows the adjustable horizontal and vertical blades that mask opening. The vertical blades can be opened to a full 10 inches or closed to about an inch for focusing purposes. The horizontal opening can be adjusted according to the exposure desired.



This machine makes the lenticulations, or ridges, on the film. Ordinary film, fed from reel at left, is heated and then embossed by a roller carrying the ridge pattern. Top inset shows how ridges are rolled into section of film: lower right, how light from edges of lens is broken by ridges into separate views.

that has been embossed on its base side, the face opposite the emulsion layer, with microscopic ridges. Each of these ridges serves as a simple semicylindrical lens called a lenticulation. There are about 300 of them to the inch and each one is about three ten-thousandths of an inch deep. They cannot be seen, but you can "hear" them by running your fingernail across a piece of embossed film next to your ear.

These ridges do not alter the speed or thickness of the film. They simply break up the image of the object photographed into a series of picture elements, one element for each ridge. Because of the curved surface of the ridge, these elements are not jumbled on top of each other, but separated, forming a series of stereoscopic pictures all on the same film. When you look at the picture with the ridge side toward you, the curved surfaces act as a selecting screen, allowing each of your eyes to see one of a stereoscopic pair of images. The rest of the series of panoramic views recorded in the composite picture is screened off by the curves.

The use of lenticulated film in an ordinary camera will give depth but not the movement perspective—"seeing around"—effect essential to realistic three-dimensional vision. One way to obtain this is with the scanning camera, a simple box with an ordinary lens fixed to its front panel and a sliding film carrier on its back. During exposure the camera moves laterally past its subject. As it does so, the mechanized film carrier travels slightly faster to keep the continuous panoramic series of subject

glimpses centered on the lenticulated film.

Because it requires a time exposure, the scanning method has now been abandoned for a camera with an extra-wide-diameter lens. This gives the same viewing range, but permits instantaneous exposure. The Navy is using a new 10-inch diameter lens. Since this is four times as wide as the normal distance between the eyes, the observer of the finished picture can move his head from side to side and see around objects as one would in nature.

This big Navy lens, now being made by several optical concerns, weighs between 135 and 145 lb. Use of plastic lenses may cut its weight to somewhere between 10 and 30 lb. And, since only a rectangular portion of the lens is used in Trivision photography, Winnek hopes to trim both weight and cost still further by having lenses made that are rectangular to begin with.

Cold-Light Printer Reverses Image

The large-diameter lens produces a pseudoscopic negative—the foreground appears where the background should be and vice versa. This is corrected in the new Trivision printer, which resembles an ordinary copying camera except that it also uses a wide-diameter lens, masked to a rectangular opening as in the camera. Cold light passes through a diffusing glass and then through the Trivision transparency, placed with the flat side toward the light source. The wide-diameter lens then projects a reversed or corrected three-dimensional image onto the special printing "paper," on which the lenticulating process has to be repeated.

This "paper" is really cellulose sheeting, .003 inch thick, coated with an ordinary printing paper emulsion. To make it three-dimensional, the coated cellulose is given the same lens ridges by running it through a lenticulating machine. The print is processed in the normal way; then, while still wet, it is squeegeed against a paper backing having a high reflective surface. The result of the process is a three-dimensional photographic print.

A photomechanical reproduction process for Trivision pictures is now being perfected. Winnek, who has been working on this for some time, is confident that by the addition of a simple lacquering and lenticulating unit to ordinary printing machinery commercial reproduction of three-dimensional magazine covers, window displays, advertising cards, book jackets, inserts, etc., will be possible within a year. The value of such a process to the Navy in making visual aids for its training program is obvious.

The ability of Trivision to record movement on a single film will make it useful, too, in other fields, especially medicine. Already such actions as the movement of the jaw, the twisting of the wrist, and the tightening of the muscles have been recorded, and the motion studied in three dimensions.

This motion record is made with the new Trivision camera by moving a mask across the lens. A tiny vertical slit in the mask admits an image to successive parts of the film during an exposure of several seconds. When the finished picture is moved before the eyes, the resulting stimulation of successive images along the retina causes an illusion of natural motion.

Used in aerial photography, Trivision has the great advantage of enabling the exact latitude, longitude and height of the terrain to be read directly from the film. This technique is the same as that used in Trivision X-ray photography, using a grid superimposed on the picture. Since the apparent movement of any object on the ground in relation to the grid bears a direct relation to the distance between them, measurement of this movement tells how far the plane was from the ground at this point.

Another attribute of Trivision, valuable for military aerial photography, is its ability to detect and record the direction of movement of ships, waves (the ocean variety), and mobile equipment and troops.

Jet Planes May Keep Camera Stable

A basic problem in using Trivision for aerial photography is keeping the camera stable during the flight. Jet planes may help in this, however, since their speed over the ground is so great that the camera will probably not have time to jar during the exposure.

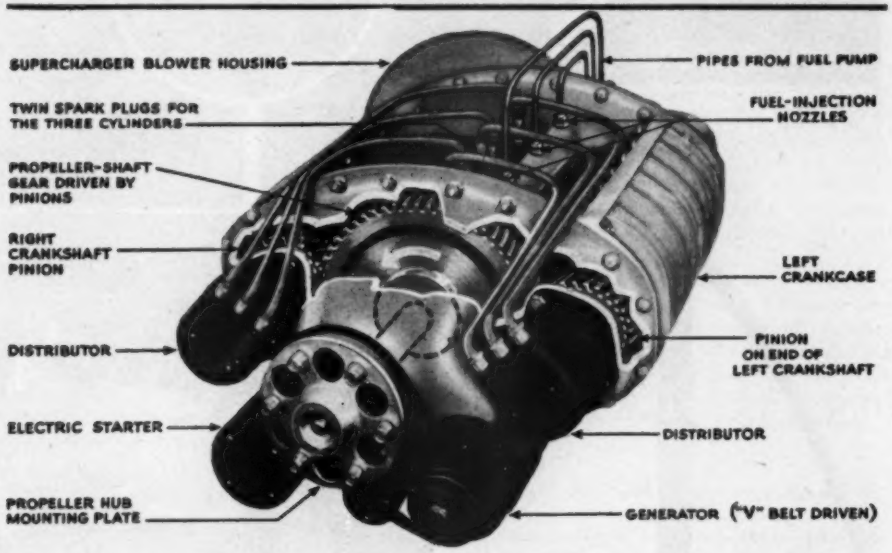
As for the amateur, Winnek sees no reason why he should have to go on being satisfied with flat, lifeless pictures. The heavy, expensive, 10-inch diameter lens, is of course out of the question. Winnek expects, however, a camera with a 2½-inch or smaller plastic lens, which, while not having the same viewing range, would give all the three-dimensional depth of the large commercial camera. As for the film, the em-

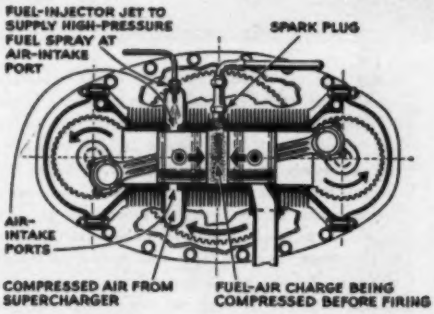
bossing process is so simple that once it is in commercial production it should be within reach of the amateur's pocketbook.

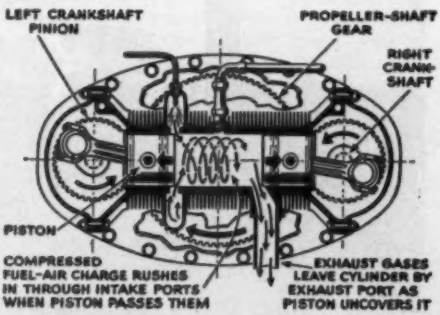
Although it is impossible to reproduce actual Trivision pictures with this article, the writer can attest to their complete effectiveness, both as to three-dimensional quality and movement perspective. He has seen several Trivision color transparencies; in one, a bust of Shakespeare in front of a curtain, the statue projects out in front and the curtain appears to be in space behind it. A pencil point properly placed actually appears to go between the statue and the curtain. By moving your head from side to side you can "see" around the bust.

Trivision movies, the perfection of which was Winnek's starting point, were necessarily shelved during the war. He is again working on them, but says only that he has definitely proved that the fundamental principles of Trivision will work for the production of motion pictures. He adds, cryptically, that Trivision movies will not need a screen.

How will it be done? Your guess is as good as ours—right now Winnek isn't talking. But you've heard of parabolic mirrors and virtual images, haven't you? END

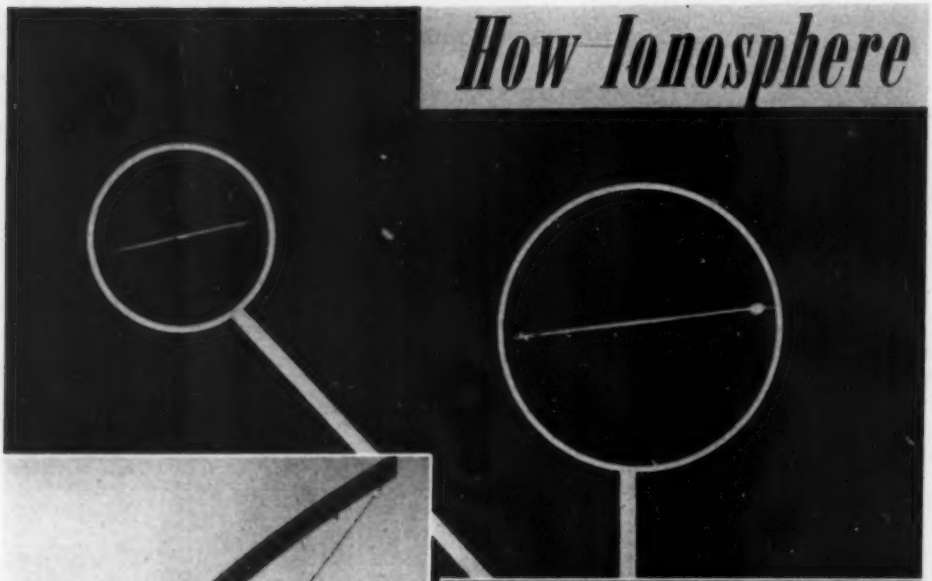


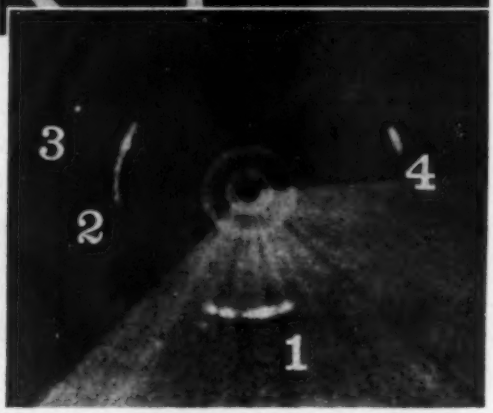


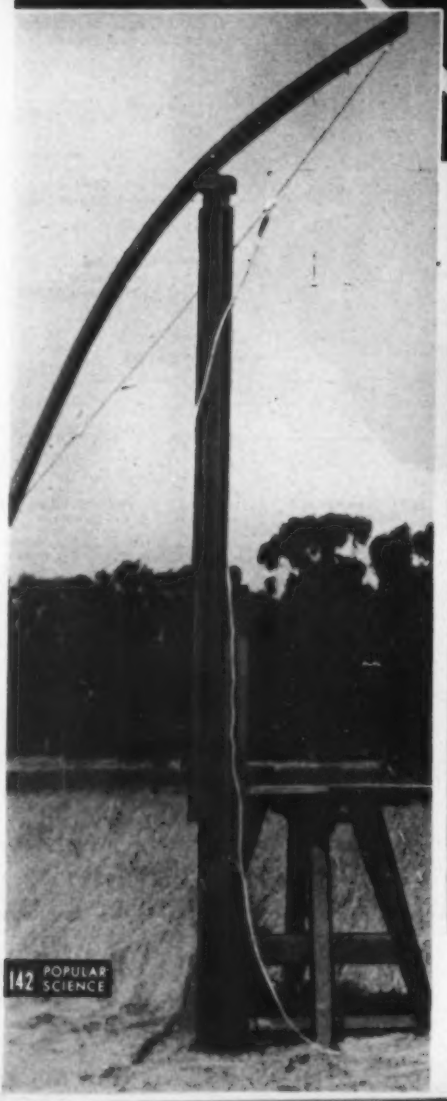


Three Cylinders, Six Pistons. This small two-cycle gasoline engine works like a man elbowing through a crowd: Its three cylinders are double-ended; each explosion drives two pistons at once. Intended for boats or planes, the 120-hp. motor weighs only 150 lb.—100 lb. less than any comparable aircraft engine, says McCulloch Motors, of Los Angeles. Fuel economy equals the best four-cycle engine's.

How Ionosphere







Radar and high-frequency radio beams are now being used to track meteors in research aimed at better short-wave broadcasts. To the human eye, meteors look like brilliant streaks in the top picture, made by Stanford scientists during the display that followed the Giacobini-Zinner comet last October. But on a radar scope, meteor trails show up as the circular segments seen directly above. Radar observations were conducted by the National Bureau of Standards during this same meteor display, but did not record the particular meteors shown in the top photograph. At left is the receiving antenna, a half-wave doublet tuned to 29 megacycles, used to "listen" to meteors at Stanford—the reflected radio wave sounds like a whistle in the earphones.

Makes Short-wave "Weather"

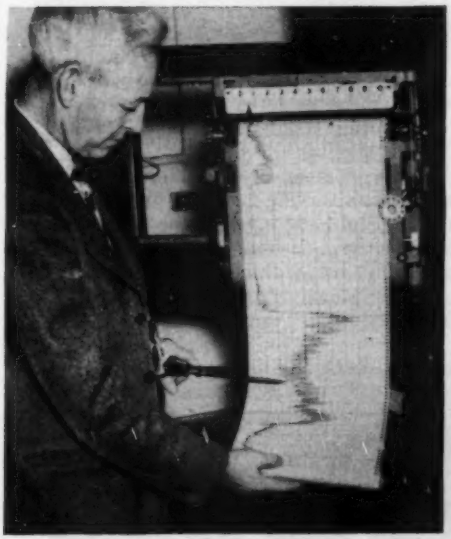
RADIO broadcasters now get their own "weather reports" predicting clear or cloudy conditions—but they don't tell engineers when to wear their rubbers. The forecasts, prepared from nation-wide observations by the National Bureau of Standards, warn when and where to expect short-wave broadcasting troubles. Thus stations with several frequencies can choose the one most likely to get through.

Basis of the forecasts is study of the ionosphere. This layer of electrically charged particles, 50 to 200 miles above the earth, reflects radio waves and makes long-distance broadcasting possible. It will not reflect all waves, however. Above a top frequency—which varies daily with ionospheric changes—the waves keep right on out into space and are never received on earth. Ionospheric conditions also determine how high a reflected frequency will go before bouncing back. This height tells the distance a radio wave will skip between transmitter and receiver, and thus whether the frequency should be used for long- or short-range communication.

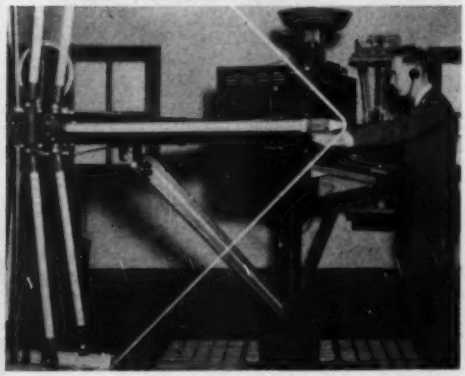
Meteors, too, affect short-wave broadcasting. Millions of small ones burn up in the earth's atmosphere every day and leave trails of hot gas. These reflect certain radio waves (some radar and old-style, lower-frequency FM particularly) that would ordinarily pass through the ionosphere.

To keep tabs on the peculiarities of the ionosphere, scientists probe it with radio beams. They transmit various frequencies and measure the time it takes for the echo to come back to the receiver. That tells how high each frequency goes before being reflected. With direction-finding equipment, they also follow the route the wave picks in the ionosphere. Meteor trails, more highly ionized than the ionosphere, can be tracked across the sky with certain very-high-frequency beams like radar. Still more information is obtained from V-2 experiments and sunspot studies.

The importance of this radio forecasting was proved during the war. Fifty observing stations all over the world provided day-to-day reports on broadcasting conditions. It was not just coincidence that the Allies started no great battles when ionospheric upheavals were wrecking radio service.



Ionosphere investigators hope to straighten out the wavy line (left), that represents variations in the signal strength of station JAE3, Tokyo, as heard in California. Ionospheric fluctuations make most of those wiggles. Below, Dr. Robert Helliwell, director of the Stanford project, operates equipment that follows radio waves through the air.



Storing Sounds on Spools

Norman Corwin records on wire his interview with President Eduard Benes of Czechoslovakia in the Presidential Palace at Prague. Lee Bland, CBS technician, operates the apparatus in the foreground.

By ROBERT GORMAN

OF ALL the devices that talked themselves into the history books during the recent war, none talked longer, louder, or clearer than the continuous-strip recorders. They put the voice of battle onto thousands of miles of wire, film, and metalized tape. Now they are ready to make records of Junior's first words, sister's progress on the piano, and your own favorite Saturday night quartet. Business firms, too, will use them for dictating letters, training personnel, recording conferences, and issuing interoffice memos.

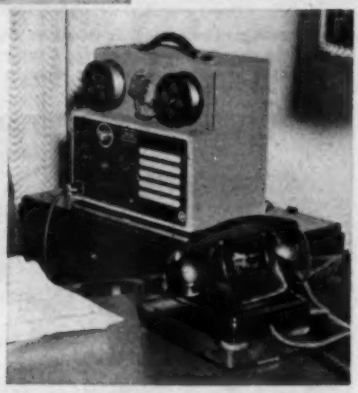
The recorders are of two different types: one impresses varying magnetic impulses on wire or metal-coated paper; the other embosses fine lines on film. This film method, incidentally, has nothing in common with the optical sound track used on standard talking pictures.

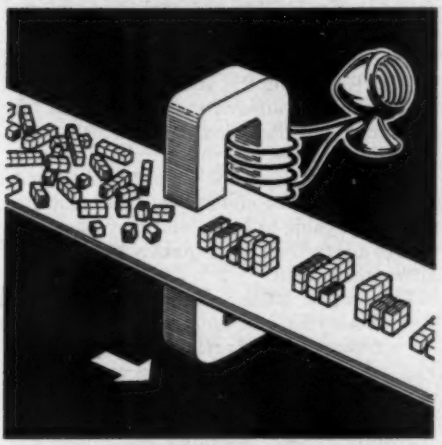
The Magnecorder, shown at right, employs a capstan wire drive that keeps the speed constant, has separate erase, record and playback heads. It uses the same wire as other machines but at double speed.

An early combination radio and wire recorder, made by the WiRecorder Corp., is shown at left. Such combinations are indicated for the future.

The pad on which the telephone rests (shown below with the Pierce recorder) is an induction microphone that records on wire both sides of a conversation.

Built by the Armour Research Foundation, the recording unit at left is installed in a combination cabinet.





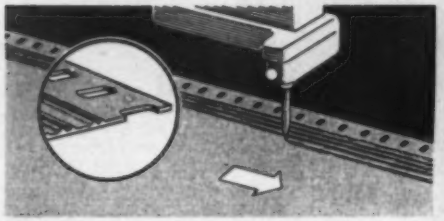
The magnetic molecules in a wire may be compared to tiny bar magnets riding a conveyor belt between the poles of a varying electromagnet. They are arranged with varying polarity, strength, and position corresponding to the current in the coil. Current is actuated by impact of sound waves on mike.

Denmark's Valdemar Poulsen invented the magnetic wire recorder in 1896. Reproduction was poor, the wire was expensive and difficult to manage, and Poulsen's invention was consigned to a "pending file" for future scientists.

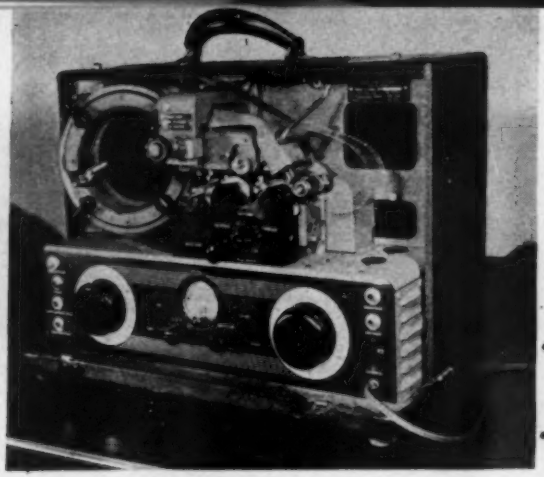
In principle, magnetic recording is extremely simple. Its heart is the humble electromagnet. If a wire carrying an electric current is wound around an iron core, the current sets up a field that renders the core magnetic. Every time the direction of the current changes, the polarity of the magnet changes also. Since, by means of a microphone, sound can be converted into varying electric currents, the current that flows through the coil—and hence the magnetic flux—can be made to vary in accordance with the sound. When a wire is drawn past the poles of the magnet, portions of the wire will be magnetized in the same sequence and intensity as the voice currents fed to the magnet. To reproduce the original sound, the magnetic impulses impressed on the wire are used to induce corresponding voltages in an amplifier system.

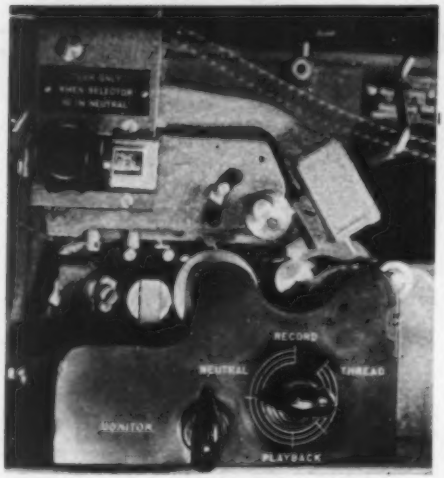
High background noise, poor frequency response, and distortion due to the magnetization properties of most materials bothered the early experimenters. A big step over these difficulties, however, was taken with the development of the high-frequency bias technique, in which the varying voice currents are superimposed on a much more rapidly varying electric current. This bias frequency, usually in the supersonic range (30-40 Kc.), effectively "softens up" the wire, making it more responsive to the magnetic variations of the voice frequency. The bias frequency is also used to wipe the wire clean of previous recordings. This can either be

The Hart "Recordgraph" at right, with a 50-foot film reel traveling at 60 feet per minute, is good for about one and a half hours of continuous recording.



An embossing needle records sound on film in fine wavy lines as it passes below. Another needle traces these lines and reconverts them into sound.





Closeup above shows film recorder's cutting and playback styluses. Automatic counter tells instantly on which of the 115 tracks the machine is working.

done separately or at the same time that a new recording is made. The wire can be reused as often as desired.

War shoved magnetic recorders out of the laboratory and onto the production line before they were quite ready. On some of the machines background noise was extremely high, the wire was liable to break, and some of the metal alloys in use lost their magnetism. The Government wanted recordings that were permanent—and the armed forces began to look with increasing favor on a rival recording method.

The new machine, built by Frederick Hart & Company, was based upon an ingenious adaptation of old-style record cutting. Instead of engraving grooves on a flat disk, however, it embosses fine tracks on a band of ordinary 35-mm. movie film—without the photographic emulsion. This is drawn lengthwise under a cutting stylus that makes 115 parallel tracks in the 35-mm. width. Each time the stylus moves over to a new track an automatic counter clicks off a number. The film winds continuously from the inside of the reel back to the outside, so it does not have to be separately rewound for playback. In combination, these features make it possible to locate and play back any part of a recording more quickly than by any alternate method.

In a pinch, these machines can operate continuously for nine hours at a stretch. Use of a voice-operated relay that stops the film when no sound hits the microphone allows it to be left in operation, unattended, for even longer periods.

Now magnetic recording has a new development—metallically coated paper tapes. Magnetic recording can be done not only on wire but on any ribbon that will take a magnetic impression. Various types of coatings have been successfully applied to paper tapes. Paper is cheap, uniform, easy to produce, and shows little tendency to snarl. Because of lower cost and ease of handling, tape recorders will be strong competitors for home use.

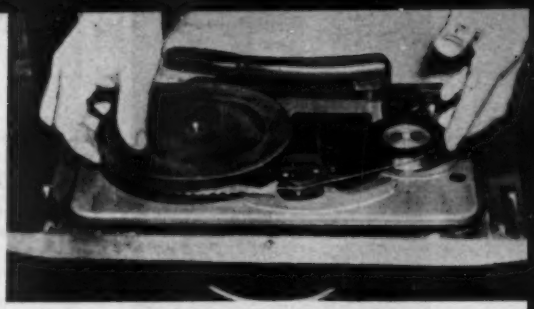
At last a large number of manufacturers of home and office recorders are tottering on the brink of production. If you pick one for your own use, here are a few points worth remembering.

Frequency range of recorders is important —up to a point. For human speech, a band from about 100 to 3,000 cycles per second is plenty wide. To take radio programs—voice or music—off the air you are not likely to

need any recording frequencies beyond 5,000 cycles since most broadcasting stations are limited to that range. But the highest fundamental note of a piano is over 4,000 cycles, and the audible harmonics that give tone and vitality to music go much higher. Response on most film recorders drops off sharply above 3,500 cycles, but special-purpose machines have raised this to 5,000. Magnetic tapes are in the same class as the better embossed-film recorders. Wire recorders, depending on make, range from 6,000 to as high as 15,000.

The permanence of the recording is another consideration. The old problem of magnetic impressions bleeding off wire has been fairly well licked. Wire made of the now standard stainless steel alloys may be stored for years without noticeable deterioration of the magnetic sound track. In addition, wire is practically indestructible and can be replayed thousands of times. Magnetic tape, while not as durable, is said to be good for at least 1,000 plays. Film, on the other hand, will last indefinitely on the shelf, but is worn out after the playback needle has scratched along it about 30 times.

Film is much cheaper than either of its rivals as a recording medium if all recordings are put in a permanent file. On the other hand, once a sound track has been scratched on film, it is there to stay, while both wire and tape are erasable and the same footage can be used over again and



First wire recorder to reach the home market, the St. George unit has a combined erase-record-playback head; uses the windup reel as a turntable.

again. Erasure can also be used to edit wire and tape recordings, or unwanted sections can be cut out and the loose ends tied or pasted together. For all practical purposes, film can't be edited except by retranscription onto another machine.

A typical wire unit that seems slated for mass distribution is the St. George Recorder. It is an attachment only, stripped down to essentials to retail for slightly less than $100. Its most ingenious feature is a windup reel that doubles as a turntable for ordinary disk recordings. The crystal pickup will play these back through the amplifier or re-record them on wire.

A tape recorder with a built-in amplifier is offered by the Brush Development Company. This machine rewinds the tape at a speed ratio of 30 to one, making it possible to play back a recording almost at once. The tape can also be reeled forward at high speed, to reach a selection at the tag end.

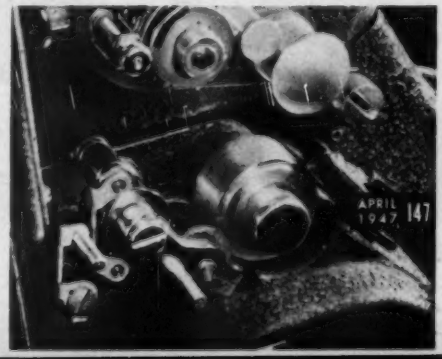
Magnetic Strip on Film Promises Low-Cost Sound Movies

In one of the newest applications of magnetic recording, a metallic material is bonded onto movie film to allow for the addition of a magnetic sound track. It is not affected by photographic solutions, and the sound may be erased and altered at will.

Magnetic recording equipment may soon be added to cameras, so that live sound can be recorded at the time of filming. This promises to bring the cost of sound recording far below present levels.

On 16-mm. film, a frequency range of 50 to 5,000 cycles is obtained; slower-moving 8-mm. film gives about half this range.

Marvin Camras, of the Armour Foundation, shows how a standard sound projector has been modified to take the new sound film. Closeup shows the enlarged flywheel stabilizer (lower center) on which the film travels. The small black oblong brushing against it contains the magnetic head.



The tape recorder at left for home or office use is made by the Brush Development Co. It can be connected to a radio to record broadcasts.

The Brush "Mail-A-Voice" makes records magnetically on finely coated paper disks, thin enough to be folded and mailed. Same machine plays disks.

Many more elaborate combination models—most of them using wire—are planned. These will be integral radio-recording units with such refinements as automatic logging timers for locating short selections on a long spool, and high-speed forward drives.

Business and office applications are a promising field for magnetic recording development. The Pierce dictating unit is one well adapted to commercial uses. For transcription the machine plays back through either loudspeaker or headphones. A foot-operated switch helps a typist to rewind, back-space, or move forward with ease. A mixer permits up to four microphones to be used simultaneously for recording conferences, and the orderly executive who likes to keep records of important phone calls need only place a small padlike microphone near the induction coil of his phone to get a transcription of the conversation.

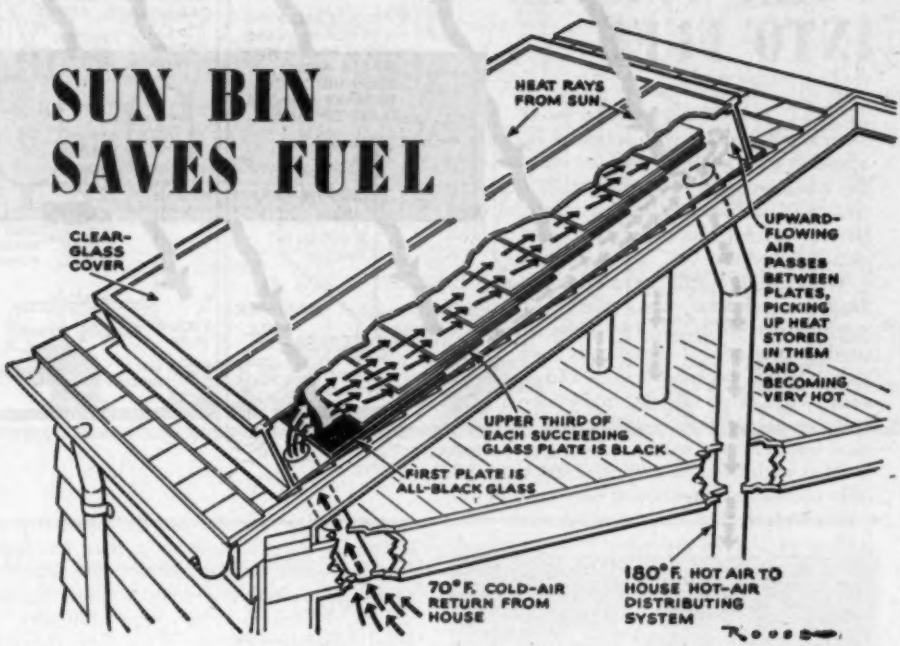
The Magnecorder, priced out of reach of most home-recording enthusiasts ($1,500 without accessories), has engineering refinements for professional and broadcast use. The wire, not the spool, is driven by a precision-timed capstan to keep flutter and "wow"—the dissonant effect due to poor speed regulation—to a minimum. The wire travels at four feet per second (twice as fast as in other models), and has a 50- to 12,000-cycle frequency range.

So far, very little has been done to provide commercial libraries of wire-recorded music. In anticipation, however, wire speed and sizes are being standardized although the multiple-recording problem has not yet been satisfactorily solved. Unlike wax disks that are pressed from a master, each reel of wire has to be individually run through a recording head. While one master reproducer can be made to feed many individual heads, high-speed mass production is still in the future.

Also in the future, although widely heralded for some time, is a truly portable machine that can be carried easily by reporters and others in search of on-the-spot transcriptions. The size of the equipment used overseas by Norman Corwin, shown on page 144, suggests how much improvement is still possible. END

Speed Spout. No threading is needed for this synthetic rubber plug. Made by Meco, Inc., of Portland, Ore., it can be fitted to drum by folding (above left) or stored inside (above right). Moving plug in and out (right) adjusts flow.

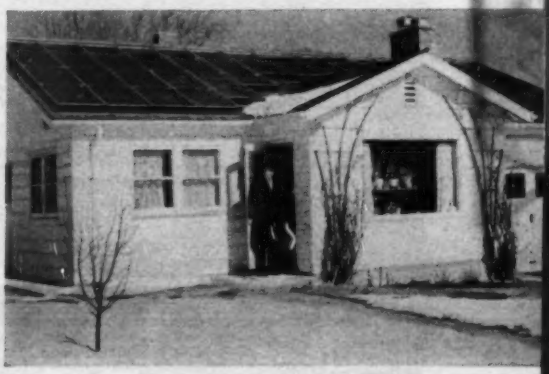
SUN BIN SAVES FUEL



THE ancient warning to people living in glass houses assumes literal significance at the University of Colorado, where glass roofs are being used to catch energy from the sun. One small house, its roof covered with beds of glass panes arranged shingle-fashion, is completely heated by this system so long as the sun shines. Although the furnace must take over at night and on cloudy days, warmth from the sun-trap reduces the annual fuel bill 20 to 30 percent.

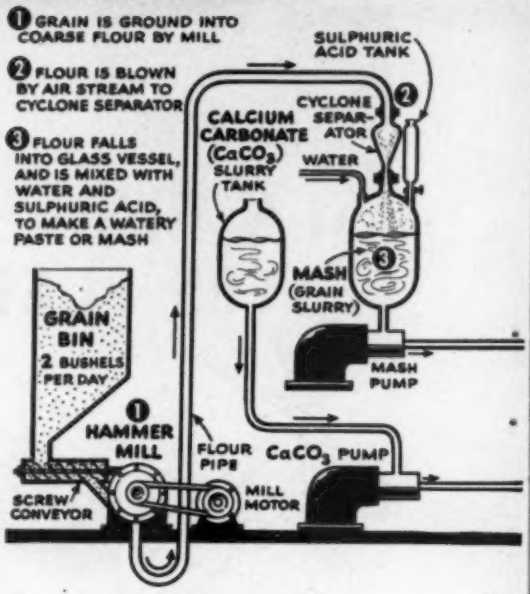
The Colorado experimental unit uses the principle employed in greenhouses. Radiant heat from the sun—mostly of short wave length—penetrates the glass top of the roof box, then the clear part of the glass shingles inside the box, and is absorbed by the painted end of the glass shingles on the very bottom. The painted glass reradiates this heat, but at a longer wave length that will not go through clear glass and so is trapped inside the box.

Cold air from the house, passing between the glass shingles, is warmed by the trapped heat waves and is then distributed through a standard hot-air heating system. Although this solar heater can provide air as hot as 200° F., it has two disadvantages: The glass shingles shatter from the constant expansion and contraction, and there is no easy way to store the heat for use when the sun does not shine. If an efficient storage system can be developed, experts figure the fuel saving may climb to 60 percent.



Dr. George Lof, head of the solar energy project at the University of Colorado, closes the door on his sun-heated home. The beds of glass visible on the roof keep the house at a pleasant 70° F. even in Colorado winters . . . as long as the sun shines.

CORN TURNED INTO FUEL

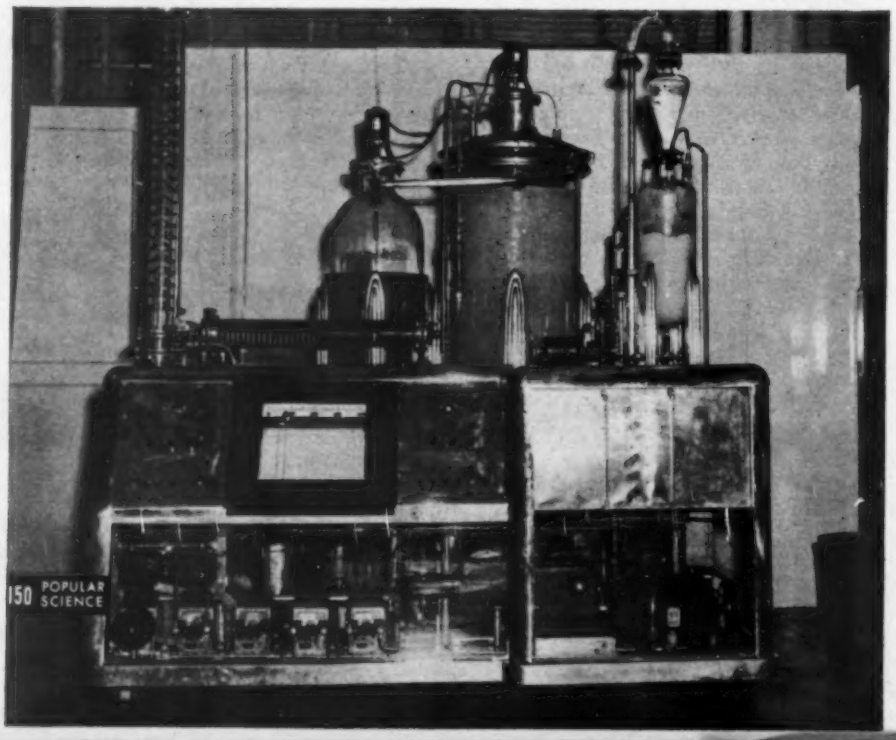


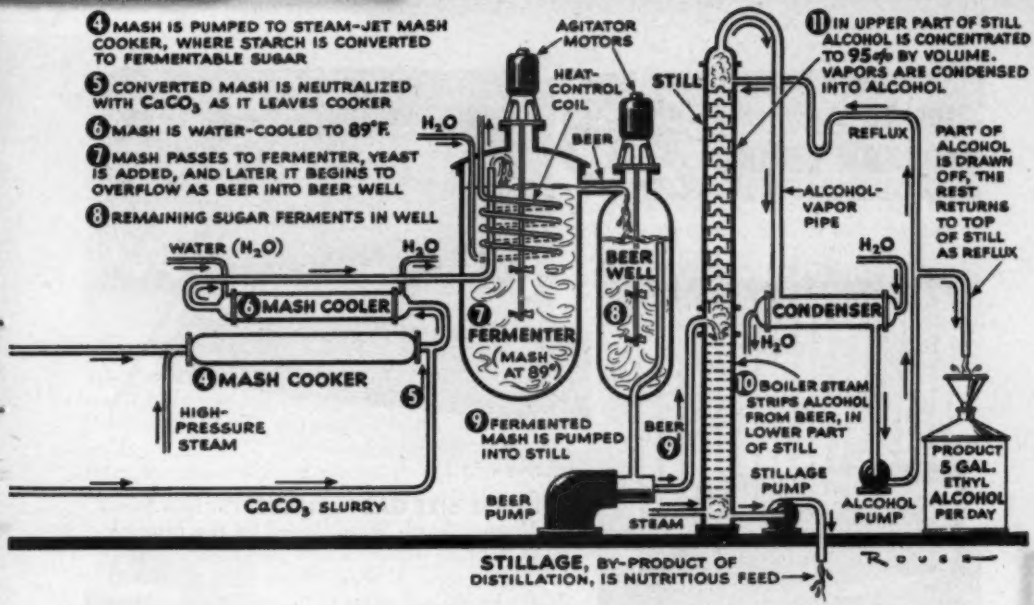
THAT old farmer who refused to replace his horses with a tractor because it wouldn't give fertilizer may be converted to the machine age yet. A new small distilling unit that processes farm crops into alcohol for tractor fuel also makes fertilizer or feed as a by-product.

With the new still designed by Joseph E. Seagram and Sons, Louisville, Ky., farmers can produce their own fuel from surplus or spoiled produce of practically any kind—grain, sugar beets, potatoes, fruits, sugar cane, wood products, and many others. The still, no bigger than a kitchen stove, is almost entirely automatic. Once the hopper is filled with the raw carbohydrate material, only occasional attention is necessary before 95% ethyl alcohol can be taken out. Five gallons of alcohol are made from two bushels of grain in less than 11 hours. And the stillage left over is a nutritious wet feed for poultry and livestock—or a high nitrogen-content fertilizer.

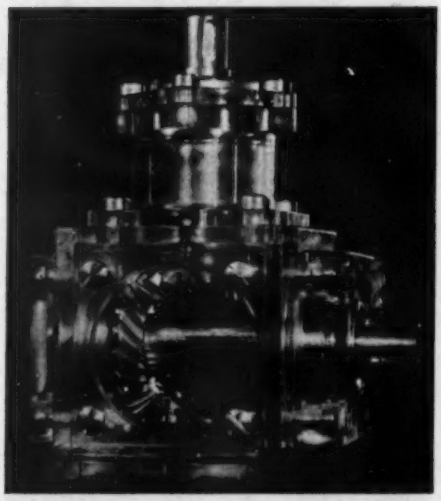
Although alcohol does not burn efficiently in engines made for gasoline, many motors are easily converted to the new fuel. But two obstacles still stand in the way of home-grown fuel. One is cost: the alcohol produced by the still costs more than gasoline. Improvements in techniques—or possibly raised gasoline prices—could change this situation, however. The other difficulty is legal, restricting the use of the unit—the product is highly potent moonshine!

Working parts of the model still shown below are diagramed in reverse order in the drawing above.

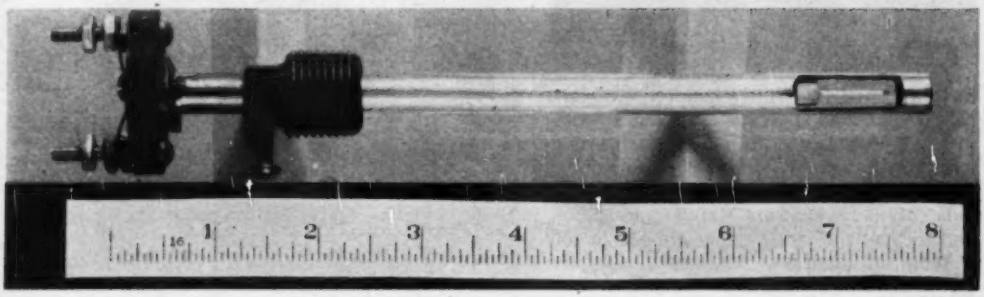




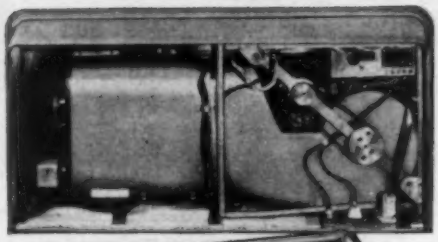
Gear in a Goldfish Bowl. You can see how the spiral bevel gear, right, works without taking it apart. It is enclosed in a boxlike case, bolted together of thick, machined pieces of Plexiglas. Turning an exterior rod operates the gear. The demonstration model was made by M. L. Bayard & Co., Inc., of Philadelphia.

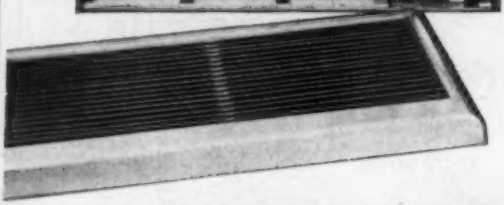


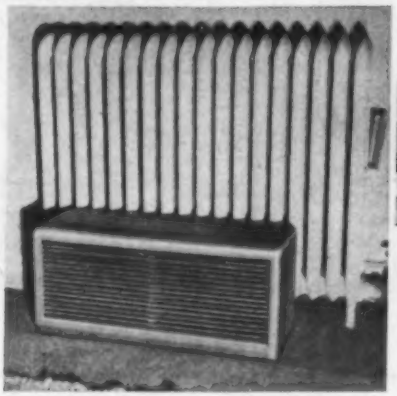
Silver Shields Superpyrometer. To test new gas-turbine and jet engines, the Navy needs an accurate temperature measure. Ordinary pyrometers have shields—to protect the thermocouples from radiant heat—that are too bulky, slow response to heat changes, and block gas flow. So the Navy and the Bureau of Standards have evolved the new type below, with a small, light, silver shield, accurate to 5° F.



AIDS TO MODERN LIVING







How the midget furnace compares in size with a radiator. The new gas-burning unit heats an average of two and a half rooms and can be installed in the walls. At top, a view of the furnace with the cover off.

SUITCASE-SIZE GAS FURNACE. The new Stewart-Warner South Wind, based on the principle of an airplane heater, is now becoming available for home use. A sealed-flame system, forced-draft blower, and vents to the outside, combined with small size, make installation possible between wall studs or in floors or ceilings. One unit is needed for each zone where different temperatures may be required, and each unit is individually and automatically controlled. Cost is comparable to that of central heating plants.

SAFETY LADDER STEP. Clamped on a rung ladder, this device provides a firm, steplike footing. The clamps are affixed to the rung from which work is to be done and to the one below, and then tightened with wing nuts. Made by the Tara Manufacturing Co., of Chicago, the ladder step is listed to sell at retail for about $3.

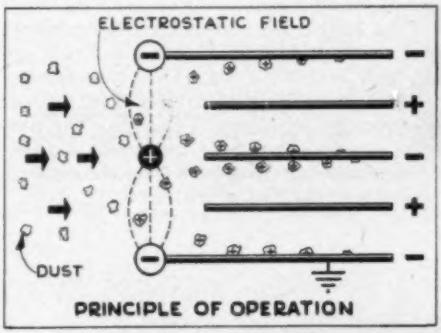
HASSOCK AND RECORD CABINET. Known as the Has-o-Rak, this space saver serves as a low seat beside the phonograph and also as a storage case for 50 records. A drop-front door provides easy access to the disks. The finish is simulated leather. Peerless Album Co., Inc., of New York, offers it for under $25.

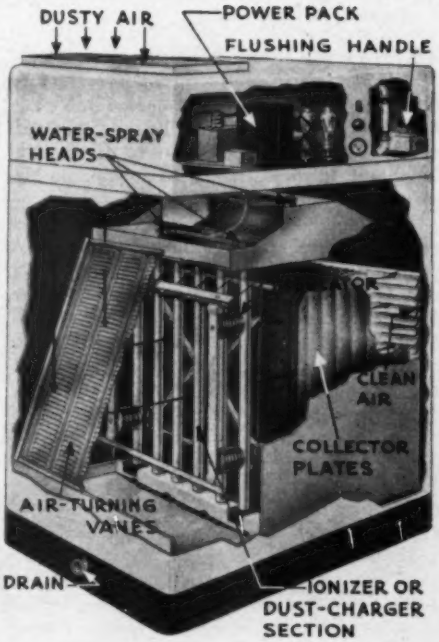
TIRED OF LUGGING A GOLF BAG? Here's a complete set of six clubs made up of only two heads and a single, adjustable-length shaft. The set is made by Jakosky Co., of Los Angeles, to retail for about $25. A second model that folds down to traveling-bag size is priced at under $40.

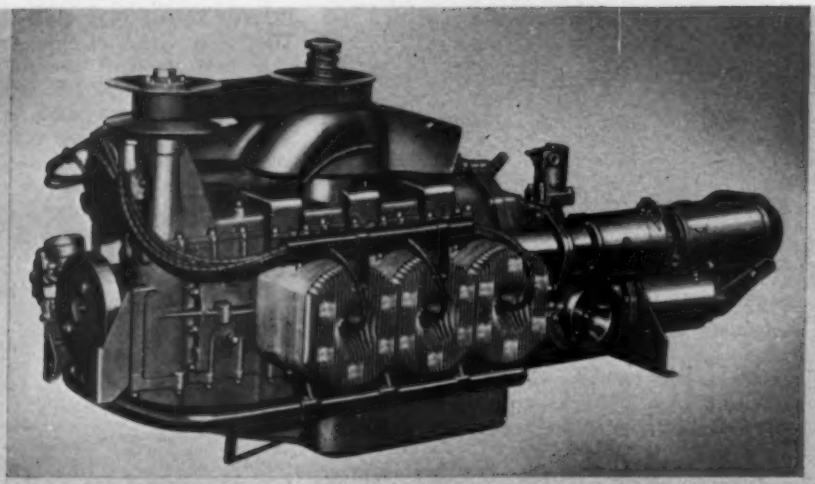
HOME CHERRY PITTER. Seeds are removed from olives, too, by this kitchen gadget. The fruit rests on a cushioned holder that protects it from bruises. Pits drop into the jar on which the plunger is mounted. R. Krasberg & Sons Mfg. Co., of Chicago, price it at $1.

POWER DRIVE FOR OLD MOWERS. The Silver Creek electric power unit attaches to standard hand-pushed lawn mowers. It is adjustable to fit various widths, power is controlled by a switch at the handle, and a lever raises the unit off the wheels to permit easy backing. Current from any 115-volt outlet recharges the battery on which the motor in the device operates.

ELECTROSTATIC AIR CLEANSER. Designed for cleaning conditioned and warm air, Westinghouse's Precipitron works on the principle of ionization. Air enters through a duct and passes through a screen of air-turning vanes to an electrostatic field where the dust particles receive a positive electric charge. Negatively charged dust-collector plates attract and hold the charged particles, permitting only clean air to pass through into the house. Efficiency of 85 to 90 percent is claimed. Collected dust in the unit is flushed out by a water spray when cleaning of the unit becomes necessary. Installed in an air-conditioning or heating system, the Precipitron has an air-cleaning capacity of 1,200 cubic per minute, enough for an eight-room house.







PANCAKE ENGINE Has Slide Valves

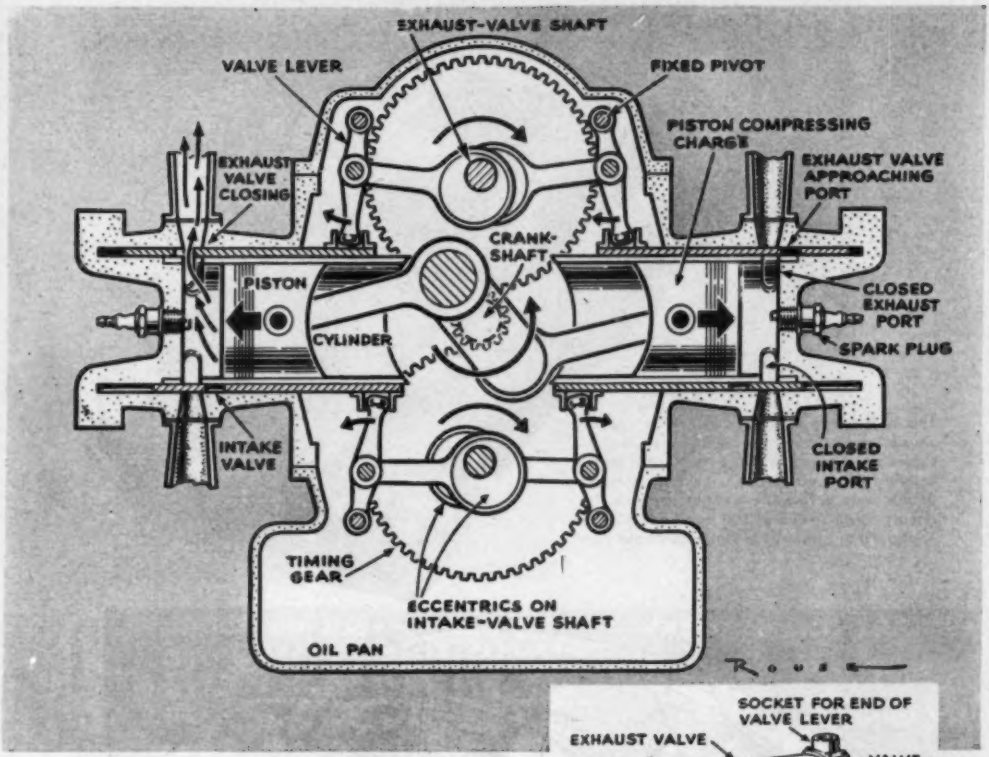
WHAT the future holds for this six-cylinder horizontally opposed engine is not yet clear, but there's a chance you may find it in some of the really new postwar cars still to come out of Detroit. Air-cooled, light, and efficient, it is said to be suitable for either front or rear drive.

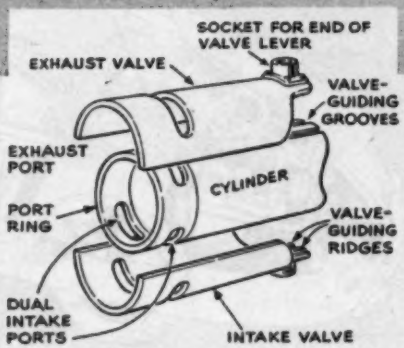
Developed in its present form to power either an automobile or lightplane, the engine first was built during the war to drive a generator in a long-distance bomber. Jack & Heintz Precision Industries, Inc., of Cleveland, produces it under license from the Skinner Motor Co., of Detroit, designer of the original engine from which this was adapted.

The valves are a variation of the sleeve valves previously employed in other engines. But, whereas the sliding sleeves used in the old Willys-Knight and other cars fully encircled the cylinder, these are split into two segments, one for the intake and one for the exhaust, and are more exactly known as slide valves. The rotary motion of a pair of eccentrics is translated into the reciprocating action of the valves by a connecting rod attached near the center of the valve lever, a ball on one end of the latter fitting into a socket on the valve and the other end operating on a fixed pivot. By eliminating the "hot spots" associated with poppet valves, the design permits the use of comparatively low-octane fuels.

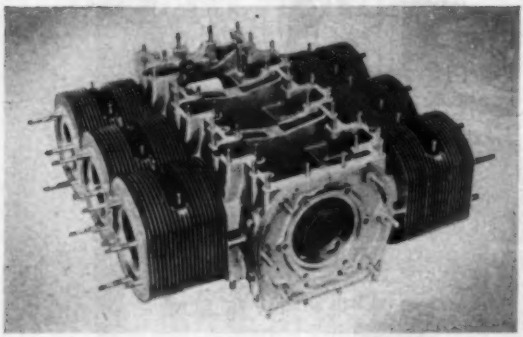
A horizontal fan driven by a thermostatically controlled variable-speed pulley cools the engine. This makes it possible to increase fan speed under conditions of low engine speed and heavy load. A built-up crankshaft permits the use of one-piece connecting rods; bearing surfaces of the rods are hardened, and the bearing metal is applied to the pins.

The engine has 126 cu. in. displacement, delivers a peak of 95 hp., and will turn up as high as 7,000 r.p.m. Fuel consumption is said to be 25 percent less than that of comparable conventional engines. The die-cast components in the engine should cut down manufacturing costs once the original expense of the dies is recovered.

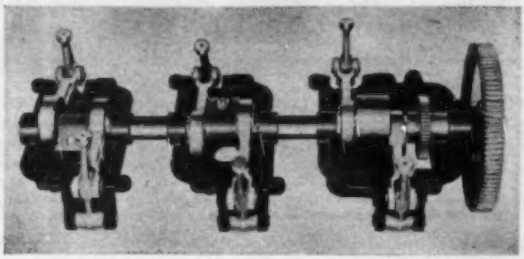




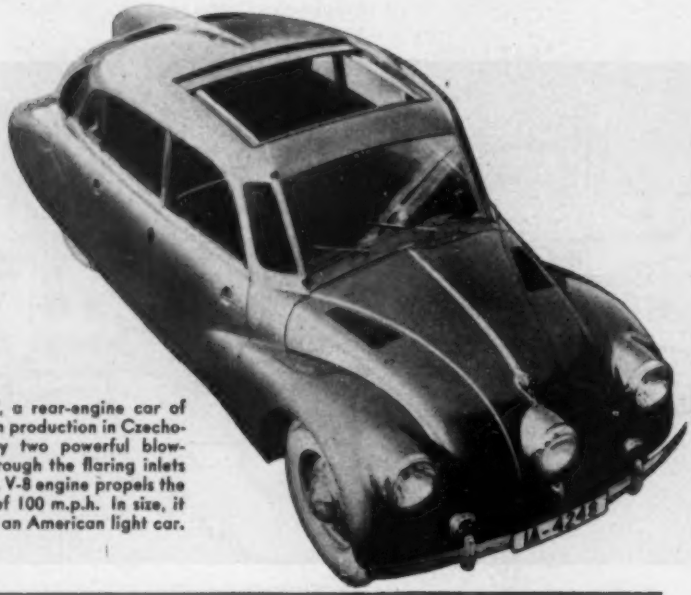
Each valve consists of a slotted segment outside the cylinder liner; together, intake and exhaust valves extend around the liner. The ports are opened on both the outward and the return strokes of every valve segment.



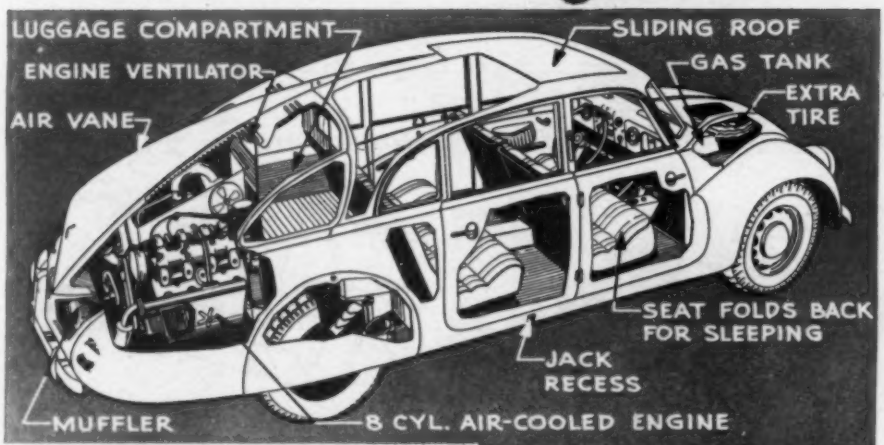
Die-casting keeps down the cost of the cylinders and crankcase, and the use of light alloys reduces the weight. Here are the cylinder barrels and block.

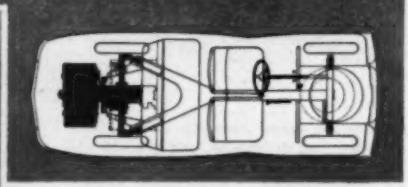


Two valve-shaft assemblies are used, one driving the exhaust valves and oil pump and the other the intake valves. Each shaft is driven at one fourth the engine speed, eccentrics and a pivoted lever carrying the action to the valves. At right is one valve-shaft assembly.



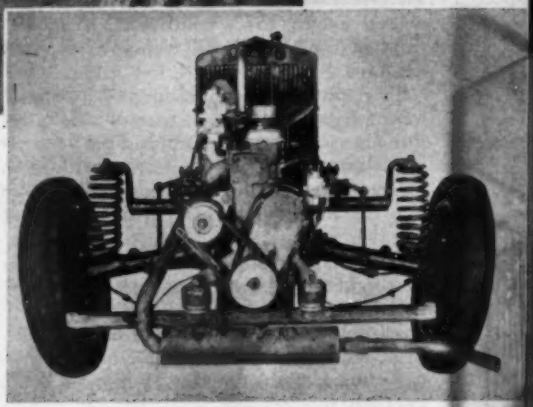
This is the Tatra 87, a rear-engine car of unusual design now in production in Czechoslovakia. Cooled by two powerful blowers that draw air through the flaring inlets at the back, a 75-hp. V-8 engine propels the car at a top speed of 100 m.p.h. In size, it is about the same as an American light car.





Built of light materials, the Tatra engine adds little more weight than is usually found at the rear of a car. Shown in black above, the entire power unit readily rolls free for servicing after the engine cover, bumper, and muffler are detached and the rear of the car is jacked up. As illustrated directly above, the Tatra rests on a Y-shaped steel backbone.

Although small, this rear-engine Renault carries four persons. Now being tested in France, it is built for economy, having a 4-cylinder water-cooled engine that is said to give 47 miles on a gallon of fuel, with a maximum speed of 56 m.p.h.



Czech and French DREAM CARS

Supermodern models designed by two long-established auto manufacturers in Europe have removable rear engines.

By R. P. STEVENSON

IMAGINATIVE artists for years have been sketching cars of the future as sleek vehicles with superstreamlining. Now in production in Czechoslovakia is a car that approaches these dream cars in appearance about as closely as anything yet produced on either side of the Atlantic. It is the Tatra 87, a sedan with smooth, sweeping lines, a rudderlike air vane at the back, an air-cooled engine located at the rear, and other unconventional features.

The Tatra, a product of the Tatra Works, Limited, is one of two rear-engine models now attracting interest in Europe. The other is an experimental four-seater midget, announced last year by the Renault company of France but at last report not yet in production. Both the Tatra Works and the Renault company are long-established manufacturers with a reputation for successful production of cars of traditional design. In addition, the Czech company was producing rear-engine cars before the war.

Whether these vehicles represent an evolutionary step that might eventually help lead some of the major American manufacturers into the rear-engine field remains to be seen, but two leading Detroit firms some time ago each imported a Tatra, apparently for study and testing. When produced, the rear-engine Renault probably will be seen in limited numbers in the United States, for this company has been sending part of its output here for more than a year.

In both cars, the engine, transmission, and

rear suspension form a single unit that is readily removable for servicing, making it possible to install another engine and keep the car in operation while the regular power unit is being overhauled.

Equipped with a 75-hp. 8-cylinder engine, the Tatra has a maximum speed of around 100 m.p.h. and a comfortable cruising speed of about 75, the gasoline mileage averaging better than 30 miles per gallon. To cool the V-8 engine, two powerful blowers drive air in large volume over the two rows of four cylinders, air being swept into the engine compartment through forward-facing inlets.

Like most other European cars, the Tatra has four forward speeds, the two upper ratios being synchronized. In size, it approximates the average American light car. The weight is 3,015 lb., wheelbase 110", overall length 187", width 66", tread 49" front and back, ground clearance 9", and height 59".

In deference to tradition, the Tatra retains a front hood but, instead of an engine, this covers the gasoline tank and the vertically mounted spare wheel and tire, with room to spare for any luggage that will not go into the big luggage compartment back of the rear seat. A searchlight, equal in size and similar in appearance to the regular headlights, is centered at the front. In the early Tatra models, this light turned with the front wheels, but this feature has now been abandoned. Two grilles in the hood carry air into the interior of the car when ventilation is needed.

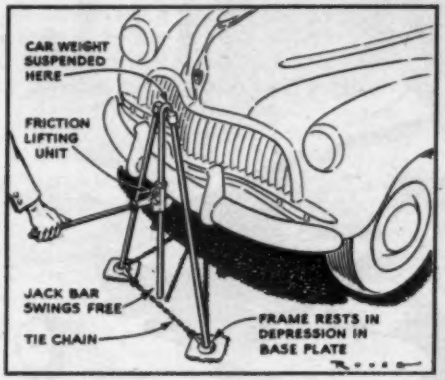
Inside, the four-door Tatra is roomy enough to seat five persons comfortably. The front seat folds back, providing sleeping space in the car for two. A low center of gravity gives the car excellent stability, knee action provides a greater degree of comfort, and hydraulic brakes for all four wheels increase the margin of safety.

A variation of the steel backbone that supports another Czech car, the little Jawa-Minor (PSM, Aug. '46, p. 136), is employed in the Tatra. But instead of a single steel support running the length of the car, as in the Jawa-Minor, the Tatra backbone is Y-shaped, two arms swinging away laterally toward the rear wheels from a position under the rear edge of the front seat. The body itself is of all-steel construction. When the car must be raised to change a tire or for other work, a reinforced recess in the body just below the rear door provides an accessible place to locate the jack.

Like the majority of European cars, the rear-engine Renault is tiny by American standards, but it seats four comfortably. Weighing only 1,146 lb., it has a wheelbase of 83", the overall length is 142", the tread 47", and the overall width 56". Independent suspension is employed on all four wheels.

Engineered for high operating economy, its 4-cylinder, overhead-valve engine develops about 16 hp. at a maximum speed of 56 m.p.h., and gives around 47 miles per gallon of gasoline. A radiator is located directly over the rear axle, a belt from the camshaft driving both the water pump and fan. The fan draws in air through grilles located just ahead of the rear fenders. Mounted immediately behind the rear wheels, the engine delivers power through a single-plate clutch and three-speed transmission, with synchromesh engagement of the two upper ratios. END

A down-curving hood allows the Tatra driver a better view ahead and increases the streamlining effect.

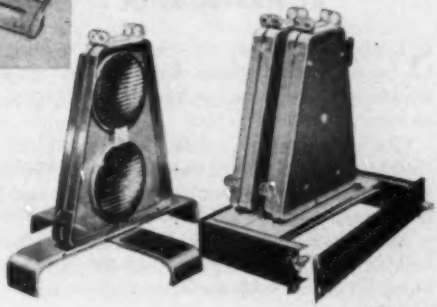


NEW BUMPER JACK. Using a suspension point that is substantially higher than the point of contact with the car, a bumper jack produced by the Johns Manufacturing Corp., of Dunellen, N. J., consists of a steel A-frame on which rests a free-swinging jack bar with a friction lifting unit. This construction is said to give excellent stability, since the bar is free to swing in any direction and compensate for any lateral movement of the car due to changes in the spring suspension while the car is being lifted.

MOP FLOWS WATER ON CAR. The advantages of a mop and a hose are combined in a new device, the "Jack Robinson" continuous-flow car cleaner, now being marketed by Corbett Patents, of Altrincham, England. Water from a tap flows through 20′ of hose, a metal pipe that serves as a handle, and sprays from the detachable mop.

MAP HOLDER FITS ON VISOR. Attached to the car visor with a strong elastic cord, the holder shown above makes it possible to keep road maps, guide books, and other reference material within easy reach and sight while driving. Produced by Visor-Ads, of West Hartford, Conn., the device is made with a clear plastic front, reinforced with steel wire to increase its durability.

WARNING REFLECTORS. Intended for use by disabled trucks, this new device employs four red plastic reflecting lenses mounted on a set of swivel-type metal legs. When the unit is set up on a highway, approaching automobile headlights are said to reflect a warning signal visible from half a mile away. Sold in sets of three and easily carried, "Reflector Flares" are produced by the Grote Manufacturing Company, of Bellevue, Ky. They meet interstate trucking regulations.



GUS Tames a Bucking Flivver

By MARTIN BUNN

STAN HICKS was on the phone a long time. From where Gus Wilson was working he could see an earnest expression on his young helper's face.

"Probably making a date," Gus grumbled, "but he's sure taking his time about it." With some annoyance he began scraping the carbon from a cylinder head.

Stan finally emerged from the office, looking thoughtful. Gus tossed the scraper onto the bench with a clatter and growled: "Hop to it, youngster. Scraping out this head is your job."

"Huh? Oh—sorry!" Stan trotted briskly over and took up where his employer had left off. After a few seconds his young face again took on a preoccupied expression. In a suspiciously offhand voice, he inquired: "Bad carburetor adjustment can cause bucking, can't it?"

"Uh huh."

"And maybe if the plugs aren't right or a valve is stuck?"

"Yup. Or if the head gasket's blown. Bring the light over here."

"Sure. What else could do it?"

"Is this a quiz, kid?" Gus grinned at his feeble joke. "What's up? We don't have any buckers in the shop."

"Oh, nothing. Just curious."

The subject was dropped, and a short while later Gus and his helper got ready to leave for the night. Joe Clark had come in and was checking over sales slips with Gus while Stan washed up.

A horn sounded in front of the garage. "I hope that's not a last-minute job," Gus said anxiously. He looked out the window and saw an aging roadster pull up to the curb. Henry Weeks, a boy whom he liked but

knew only casually, flipped open the door to let Stan Hicks hop in. Gus noticed as the car moved off that it quivered and bucked like someone skating through a gravel pit.

HELLO, Stan," Henry said with a trace of shyness. "Hope I'm not interrupting anything important."

"Heck, no." Stan tried not to notice the embarrassing bucking of the car. Because it would have been awkward either to mention it or remain silent, he cast around for something to say. "Do you still see Peggy?" he asked finally.

"You bet. She's practically my steady."

Peggy Graham was the leading belle of the high-school set. Actually Henry was overstating his claim, but she did seem to like him.

"She's one of the reasons why I called you. Though it's mostly this old bus of mine. I've tinkered with cars a good bit, but sometimes a fellow likes to consult with —er—another expert."

"Of course," Stan agreed modestly. "Why, even Mr. Wilson discusses his tough cases. I know how it is, old man."

"Anyway, this is Thursday, and the big Country Club dance is Saturday. I have a date with Peggy, only she says she won't go unless the car acts better. That doesn't leave me much time to get the old crate running right."

"I should say not, Henry." Stan tried to recall how Gus would go about a diagnosis. "Has it been bucking long?"

"Began the day before yesterday. I went to call for Peggy and her girl friend to take them for a drive. We got bounced around so much Evelyn started making nasty cracks and Peggy got mad at me and made me take her home right away quick."

They arrived in front of Henry's house, parked under a street light, and lifted the hood. An expensive new sedan coasted alongside. Turning, the two boys looked up into the face of Sumner Craven, a chubby youth of about their own age. Seated next to Sumner was lovely Peggy Graham.

"What's the matter, fellows?" Sumner asked. "Having trouble with your jalopy?"

"Hmf! Listen to him," scoffed Henry. "Just because his old man lets him use his new car he thinks he can sneer at his betters."

"Bosh!" Sumner pulled his head in huffily. "I'll bet you can't fix that car!" Then he began to laugh, let in the clutch, and glided smoothly away. Stan and Henry returned to their examination of the motor. Suddenly Stan stopped and pointed at the spark-plug wires. "Hey!" he shouted. "What's that?"

Henry stared. "The wires of those two plugs are switched!"

"Exactly." Stan tried to imitate Gus's manner. "That's why it's been bucking."

Stroking his beardless chin, Henry announced, "They were okay the last time I checked. I know enough about cars not to make *that* mistake."

"You mean you smell a mouse in the cabbage?" asked Stan.

"Putting two smells together, I get worse than a mouse. I get Sumner."

It was the work of seconds to reverse the crossed wires. Henry started the motor, and let the car move slowly forward. It picked up briskly, then gasped, rocked forward, coughed, and lost speed. The roadster was bucking as badly as ever!

SUMNER CRAVEN opened the front door of the Graham house and stepped out.

"Good night, Sumner." Peggy's slim young figure was framed in the light from the house.

"Should I call for you Saturday?"

"I can't ask you to do that," the girl replied. "I have sort of a date with Henry. Of course, I told him I wouldn't go with him if his car's going to shake out my hair-do."

"Ha ha!" Sumner started down the steps. "I'll call for you at eight on Saturday. Good night!" He climbed behind the wheel of his father's new car, snapped the switch, and pressed the starter. The engine turned over but didn't start.

"Holy smoke!" he whispered. "Something's wrong!" Nervously he tried again, with the same results. "If anything's happened to the car, Pa will have my hide." Hopping out, he lifted the hood and looked helplessly at the engine.

"Having trouble, chum?" A familiar voice drifted over his shoulder. Sumner whirled to find Stan and Henry, looking as casual as they could manage, standing behind him.

"You've done something to my car," Sumner yelled. "If you've hurt it I'll have both of you thrown in jail!"

"Do you know what he's talking about?" Stan asked Henry with an expression of exaggerated puzzlement.

"That's a guilty conscience talking,"

Henry rejoined. "The kind of stinker who'd cross someone else's spark-plug wires probably thinks honest people would stoop to the same tricks."

Sumner glared at him.

"See?" Henry went on triumphantly. "He admits it!"

"It was just a gag," growled the chubby youth. "Anyway, you found it. What have you done to my fa–my car?"

"Tsk–tsk. D'ya still think we did something to it? Of course that distributor rotor we found up the street might. . . ."

"Give it back!"

"Funny thing, it got lost," said Stan.

"But we might be able to find it," Henry added quickly, "if you could remember what else you did to my car."

"I crossed the plug wires. That's all. Honest!"

"Quit kidding." Henry dropped his flippant tone and stepped in close to Sumner. "We fixed that and the car still bucks."

There was no mistaking the expression on Sumner's face. He was honestly puzzled. A few more questions showed he had nothing further to reveal. The hand Stan had been holding behind his back came forward. It held the rotor from the sedan's distributor.

The two friends made their way back toward the roadster. Grimly Stan rolled up his sleeves. "Looks like there's no way out," he said. "We got to take off the head."

Working with few tools and little light, the two boys took even longer on the job than they had expected. Worse, they could find nothing wrong–no valves were stuck and the gasket bore up under scrutiny.

"There's only one thing left," Stan confessed wearily, as they began to reassemble the engine. "Bring the bus around to the shop tomorrow and let my boss look at it. Boy! How he'll rib me!"

GUS WILSON knew when to leave well enough alone. Despite Stan's fears, he tactfully refrained from rubbing salt on the young mechanic's wounded pride.

"We tried everything we could think of," said Stan.

"In that case," Gus replied, "the trouble must be some place you didn't think of. Let's go over it step by step."

"How about the crossed plug wires?" asked Henry.

"That might have done it easily enough, and whatever the trouble turns out to be, crossing the wires may have helped to bring it on. You checked the valves and the head gasket. Although they don't seem to be the answer, you may still have been on the right track." He raised the hood and instructed Henry to start the motor. It rumbled unevenly and coughed through the carburetor. Gus checked the vacuum at the carburetor and found it low. "That could happen," he said, "if the exhaust and intake were getting together."

"We got bounced around so much that Peggy got mad and made me take her home right away quick."

"But we examined the valves," Stan protested.

"How about the ports at the side?"

"The ports . . . ?"

"Sure. Where the gas goes in and the exhaust comes out." Gus showed Stan where to back off the nuts that held the manifold to the block. As it came loose, slivers of blackened copper fell out.

"There's your trouble." Gus pointed to a gap that had been burned in the gasket between an intake and exhaust port. "Put on a new manifold gasket and try it."

The boys set to work. When Gus strolled by a half hour later, the motor was purring.

"Okay now?" asked Gus.

"Like a dream," Henry affirmed, "I can't tell you how much I . . ."

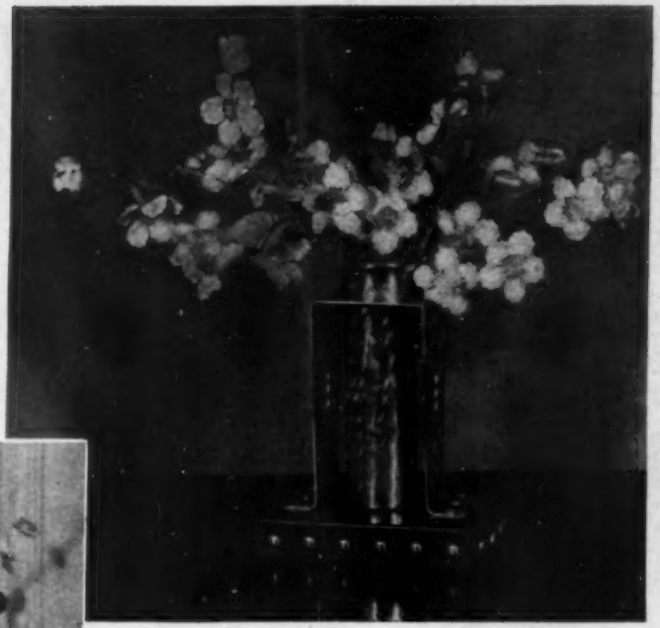
Gus waved his hand. "Forget it. But wait until I see that Craven kid. I don't say this couldn't have happened if the wires hadn't been crossed, but I'll bet a peach to a pumpkin it helped bring it on."

Henry scraped his foot shyly along the grease-blackened floor. "Please don't say anything to him right away," he said. "If he finds out that my car's been fixed before Saturday night, he'll be able to make another date. I'd like to see that double-crosser get hung up at the last minute. It would serve him right if he had to go dancing with his father's sedan!"

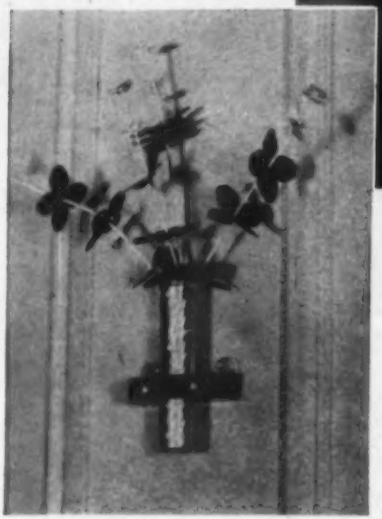
MECHANICS AND HANDICRAFT

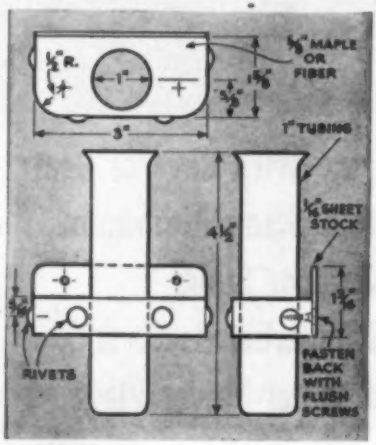
- Steam Engine with Reverse Gear
- Projects from Scrap Aluminum
- Building Outdoor Stairs
- Two-Band Superhet Receiver
- Your Own Water-Power Plant

Two vases in aluminum—one 2" by 6½" in a table stand set on a rivet-studded micarta base, and the other 1" by 4½", held in a studded wall bracket. Both are made from lengths of ordinary aluminum tubing spot-polished in a regular pattern.



Thin wood or fiber screwed to the back of the bracket with a projecting lip, as shown below, provides a means of attaching the vase to the wall. If the hole bored in the bracket is a tight fit for the tubing, the vase can be pressed in and held at any desired position.



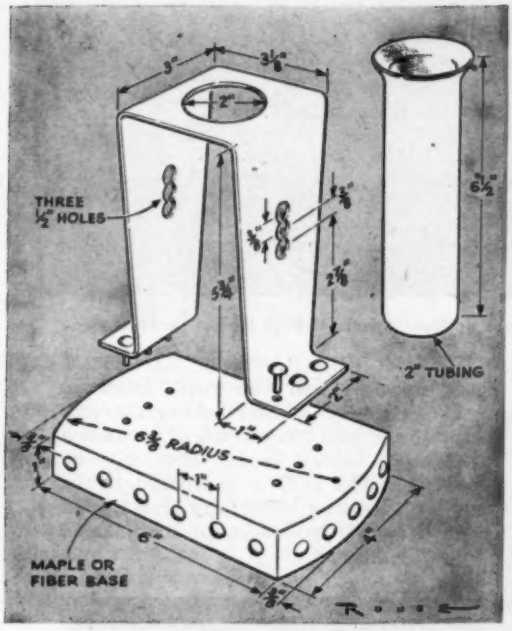


For the Metalworker... Four Projects

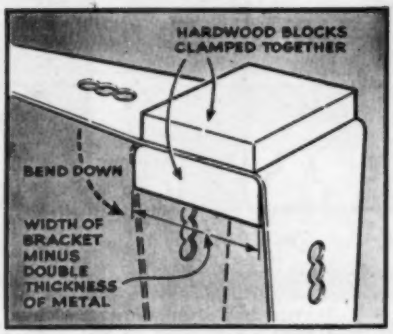
By R. J. DeCRISTOFORO

CRAFTSMEN who like working in aluminum will find tubing 1" and 2" in diameter an extremely satisfactory medium. Such projects as the vase with an ornamental stand shown above, the wall vase at left, and the pair of matching vases and dinner bell illustrated on page 166 can be made with it.

In general, the same procedure is followed for all four projects. One end of the tube is first sealed with a disk of sheet aluminum cut slightly larger than the inside diameter of the tubing. The disk is forced into the tubing, which is then held on a hard surface or anvil while the edge is hammered all around. Filing a radius and sanding smooth will leave the joint water-tight and practically invisible. Soldering can, of course, be tried, but requires special solder and considerable patience. Welding can be done



All parts of the table vase are shown in the drawing. The vase is a loose fit in the stand to permit removal for filling. Felt is glued to the bottom of the base.



Use clamped blocks as a form to bend the stand. Top edges of the lower one are rounded.

Instead of spot-polishing, a hammered effect can be obtained by peening the entire surface of the tubing with a ball-peen hammer.

from ALUMINUM TUBING

only on certain types of aluminum, some of which are too hard for easy working.

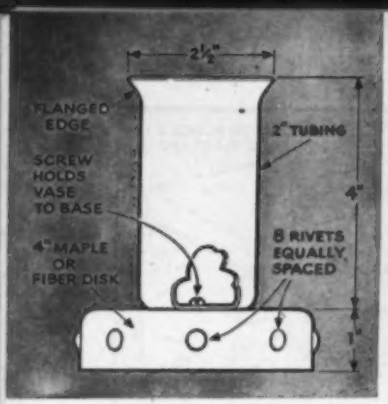
A soft aluminum, such as 24SO or 52SO, is required if the open end is to be flanged for a nice finished effect. This is done by holding the tubing at an angle over the end of a round bar or piece of pipe clamped tightly in the vise and tapping lightly with the edge of a mallet as in the photo on page 166. The bar or anvil should, of course, be somewhat smaller in diameter than the tubing. Tap about ⅜" from the end while rotating the tubing slowly.

Both hammered and spot-polished finishes are possible. The former is obtained by peening the entire surface with a ball-peen hammer while holding the piece on a round bar, as shown above. There is no need to try for a uniform pattern. Rub down with fine steel wool and light oil; then, if you want a high polish, dry the oil off thoroughly and buff with a wheel and jeweler's rouge.

Spot-polishing can be done with a hand grinder or electric drill. Hold a bolt in the chuck and wrap fine steel wool around the bolt head tight enough for it not to turn on the bolt. Circles will appear on metal parts held against the spinning abrasive. A definite pattern is best in this case, and the metal should be finished smooth before spot-polishing is begun.

For different effects, experiment on scrap pieces of aluminum with various grades of steel wool and abrasive cloth. The angle at which the work is held, the kind of abrasive used, and the diameter of the spinning abrasive all have a bearing on the result obtained. A round brass brush will also give a variety of finishes.

The stand for the table vase was laid out



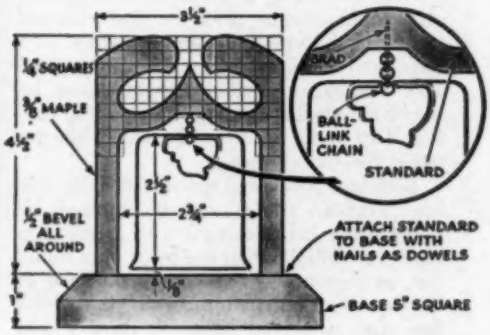
Matching vases are mounted on disk bases of wood or fiber. A screw through the bottom holds them.

and cut from 24ST aluminum sheet .064" thick (any reasonably stiff stock will serve). It was drilled and then bent between two hardwood form blocks. Some length is gained in the bends, and compensation must be made for this by shortening the length of the flat pattern. As a rule, deduction equal to the thickness of the metal at each bend will serve. Always bend metal more than the required angle to allow for a tendency to spring back. Smooth all cut and filed edges with emery and steel wool.

Bases, brackets, and the stand for the bell may all be made of maple, black walnut, mahogany, or other hardwood. Phenolic fiber or micarta can be substituted for wood in the vase bases and brackets. These materials, used in aircraft work, are rather expensive, but only small scrap pieces will be needed. When finished smooth and waxed, they often have a leathery appearance that goes especially well with maple furniture.

For decoration and for holding the vase stand to the base you can use ⅛" aluminum rivets with brazier heads. They may be filed sharp like nails or broadened at the end with hammer blows, and then tapped with a mallet into undersize holes. Don't polish the heads. END

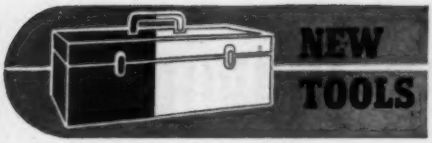
Flanging is done with the edge of a mallet while the tubing is revolved on a round bar. The hammer head and handle shown were turned on a lathe.



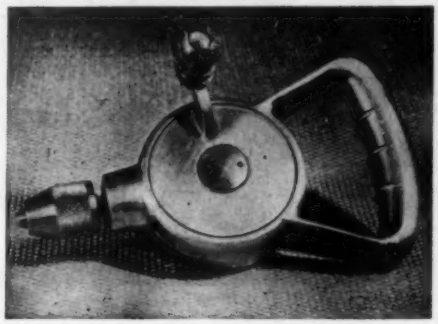
METAL CUTTER. Chucked into a ¼" electric or pneumatic drill, the Royal Clipper Metal Cutter produced by the C-B Tool Company, of Lancaster, Pa., leaves a smooth edge that requires no grinding or filing. The regular model cuts light metals up to .040" while the heavier-duty model will handle average sheet metal as heavy as .055". The tool also can be used to cut plywood, plastics, cardboard, and linoleum.

DRILL-PRESS TABLE. Cast of aluminum alloy and equipped with a cadmium-plated steel fence, this auxiliary 13" by 18" drill-press table offers an enlarged and true working surface for many drill-press operations. Manufactured by the Barron Tool Company, of Detroit, it comes supplied with an irregular shaping pin, anchor bolts, fence, and fence-clamp assembly. It sells at around $10.

PLASTIC TAPE. Thinner and less bulky in use than ordinary tape, plastic electrician's tape made by the Minnesota Mining and Manufacturing Co., of Saint Paul, Minn., has an elastic, rubberlike vinyl backing, coated on one side with adhesive. The backing has high dielectric strength.



SMALL HAND DRILL. Compact and sturdy, the British-produced hand drill below has ribs on the inside of the handle to prevent the hand from slipping while the tool is in use. First shown in London at a display of new British products, the drill is manufactured by the Leytonston Jig & Tool Co.



FINISHING HAMMER. Although designed for flattening, smoothing, and dent-removing operations in automotive shops, a finishing hammer produced by M. F. Robertson Sons Co., Darby, Pa., also has a practical value for home tool chests. Each hammer is supplied with a felt-lined metal cover to protect the face when not in use.

Illuminated Corner Shelf

Light from the base of the cabinet illuminates the objects displayed on its glass shelves, while that from the top provides a soft glow for the room.

By JAMES S. HARTZELL

HERE is something different in knick-knack shelves. This self-illuminated corner cabinet not only lights up the objects on its shelves but provides also a mild indirect room light—enough to give a soft glow in a small hall or to brighten the corner of a large room.

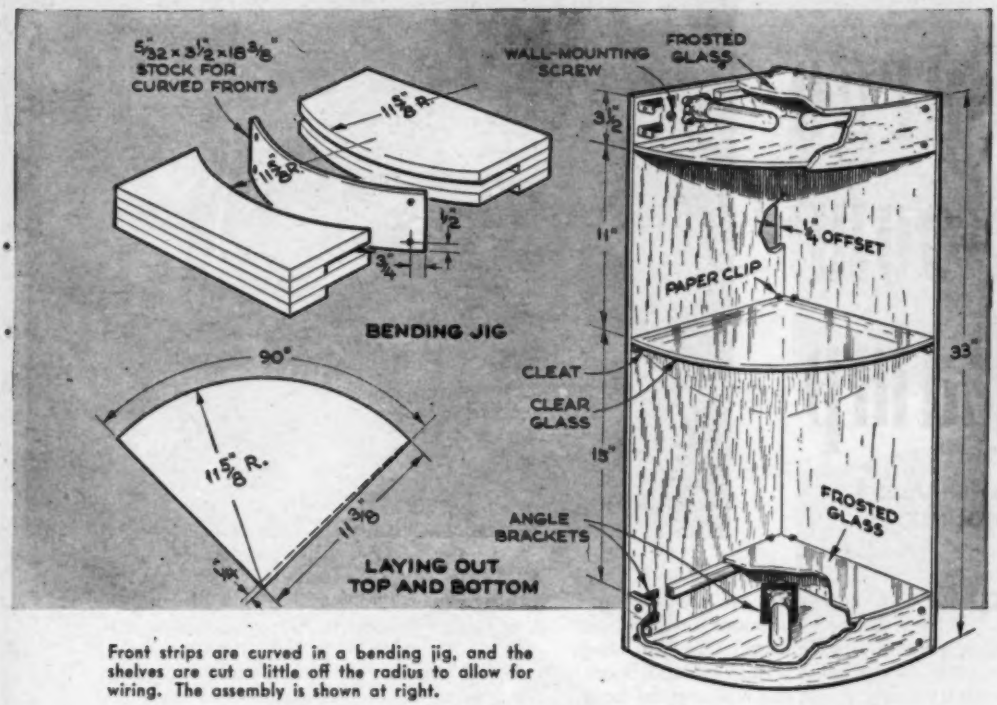
The piece is made up of two ¾″ plywood sides, two curved fronts, two ¾″ plywood members cut to an 11⅝″ radius, and three glass shelves, two frosted and one clear. Sheet plastic, sheet metal, veneer, or thin solid wood can be used for the curved fronts.

Build a form of ¾″ lumber, as in Fig. 1, if you wish to use solid stock. Across the middle of each of two 12″ wide pieces lay out a 90-deg. arc having a radius of 11⅝″ and saw through cleanly with a jigsaw or scroll saw. Build up the two concave pieces with two extra pieces of ¾″ stock, and nail all firmly to a base. Then assemble the convex sides similarly, but do not nail to the base.

Dress two pieces of clear pine 3½″ by 18⅝″ to a thickness of 5/32″ and sand smooth. It will take two days to curve the strips in a single form since each must remain in it 24 hours. First soak a strip overnight in water, dry by pressing between the folds of a towel, and then clamp in the jig. Finish by drilling the ends for ¼″ bolts.

Though the fronts of the shelves are 90-deg. arcs, the shelves themselves are not exactly 90-deg. sectors, as Fig. 2 will show, since a slice must be taken out of one side to allow a ¼″ space for wiring. This in no way affects the fit in a square room corner, and the joint still appears as a right angle when seen from the front. The glass as well as the plywood members is cut according to this pattern. Ready-cut corner glass shelves available in hardware stores have plastic mountings that afford enough support to make trimming the shelves unnecessary.

Assemble the plywood sides with nails, nail in the plywood bottom, and nail in the upper plywood piece 3½″ from the top edge. Bolt the curved front strips to the angle braces, drawing them up just enough to touch the curved fronts of the platforms but not enough to touch the braces. Then brad the strips to the platforms, puttying the holes. Mount the glasses on cleats, the clear



Front strips are curved in a bending jig, and the shelves are cut a little off the radius to allow for wiring. The assembly is shown at right.

one in the center, holding them with bent wire clips driven behind the cleats.

Line the light pockets with sheet asbestos and wire sockets for two showcase bulbs in the upper and one in the lower. Put in a toggle switch on the underside of the bottom where it will not be noticeable.

Particular pains must be taken with the finish, using both undercoat and high-grade enamel, since the light will show up blemishes. Jade green or brick red will go well with silver and other objects.

RINGS OF ANNUAL GROWTH

[WOODWORKING]

Each of the concentric rings in a cross section of a tree represents growth made during one year—from the time active growth begins in spring until the tree becomes dormant in fall. The age of a tree can be determined by counting these rings, but only approximately, for drought often causes two rings in one year. Widths of the annual rings vary according to the growth conditions.

In many woods, each annual ring is made up of two parts—inner light-colored springwood and outer, darker summerwood. Springwood is made up of relatively large, thin-walled cells formed during the early part of each growing season. Summerwood is formed later and consists of cells with thicker walls and smaller openings. It therefore contains more solid wood substance than springwood. A change from springwood to summerwood is less noticeable in hardwoods than in soft.

The proportion of springwood and summerwood present in softwood lumber has an important effect upon its strength properties and physical characteristics, according to the National Lumber Manufacturers Association. In the softwoods commonly used for structural purposes, the rate at which trees grow has an important effect on their strength. A measure of this strength is provided by the relative width and the character in each ring. Pieces with medium to narrow rings have generally higher strength than those with wide rings. In addition, in certain woods, pieces in which a considerable part of each annual ring is made up of the dense, darker summerwood are recognized as having still higher strength. Therefore, when structural material is being graded for use under known loads, the number of rings per inch radially and the proportion of summerwood are both considered. Material with a specified minimum number of annual rings per inch is termed "close grained" and that which in addition consists of at least one-third summerwood is termed "dense."

POPULAR SCIENCE MONTHLY SHOP DATA

Cargo Boom Lamp

By CHARLES S. JEGLINSKI

SEAGOING accessories are always popular in a den or game room for their note of outdoors and adventure. This wall lamp is built to represent a ship's cargo boom, with the mast against the wall and the lamp and shade suspended from the boom.

If the room is large, a pair or more may be wanted. At any rate, the mast, base, and truck should be made up as split turnings with paper glued in the joint to simplify the work. Then, if the second half is not needed, it can be discarded.

Make up the wooden parts from pine, whitewood, mahogany, maple, or any good turning stock. Note that the mast tapers from a 1¾" diameter at the base to 1¼" at the truck. Both the base and truck are turned round, and then split at the paper joint. Round off the lower edge of the truck only. All three pieces should be sanded smooth before removal from the lathe.

Cross-drill the mast to a depth of about ½" for a ⅜" brass grommet; then drill a ⅜" hole up from the bottom to meet and also drill the base. The hole thus formed takes the light cord. Glue the base and truck in place, reinforcing the former with a short length of ⅛" pipe nipple and the latter with a screw. The nipple cuts its own thread.

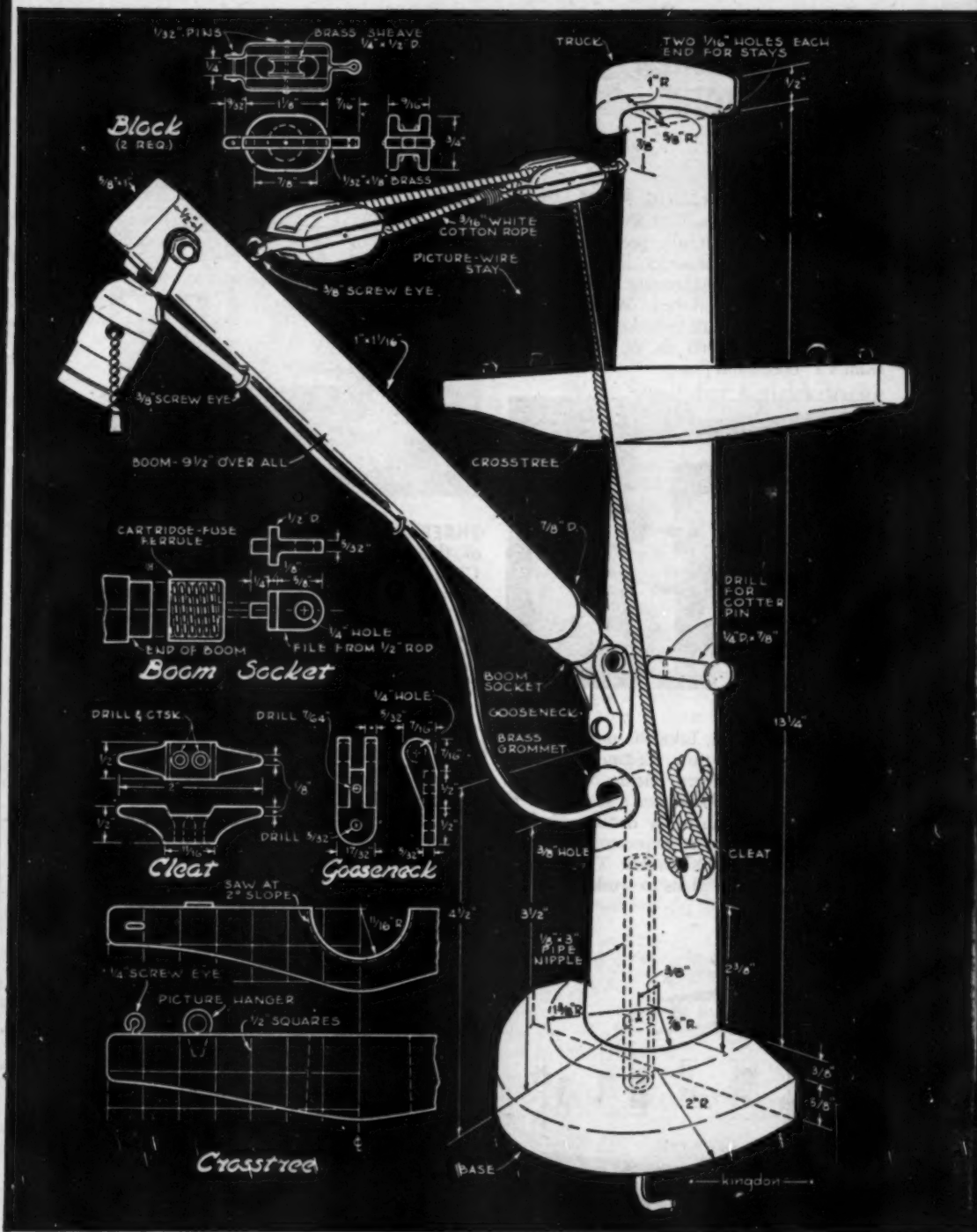
Jigsaw the crosstree to shape; the semicircular cutout should be performed as a separate operation with the saw table tilted to a 2-deg. angle so the cutout will fit the pitch of the mast. Glue in place and fasten with screws or light finishing nails driven in at an angle from the back.

Brass screw eyes in the crosstree and truck hold the stays, which are picture wire. The wire is unstranded at the ends and all but two strands cut off there. These are put through the eyes, bound around the thicker part of the wire to look like seizing, and soldered. Picture hangers on the back of the crosstree are for hanging the lamp.

Turn the boom from 1¼" stock to 1 1/16" at the center and tapering to 1" at the top end and ⅞" at the other. A ⅜" tenon 5/16" long is turned at the small end to take the boom socket. The top end is trimmed to a ⅜" by 1" flattened oval.

One of the ferrules from a renewable-type cartridge fuse (250 volt, 35 to 60 amp., or 600 volt, 1 to 30 amp.) supplies the socket. It will cut its own threads. Drill it 3/16" for a tight fit for the stud on the end of the filed brass coupling. The gooseneck is rough-cut with a hacksaw from a 7/16" by 17/32" by 1 7/16" brass block, drilled, and finished with a file.

Blocks can be obtained at a hobby shop, but it is not too difficult to jigsaw a pair from maple or ash and to turn brass sheaves. They are attached to the mast and boom with screw eyes opened to receive the end of the brass fitting and then pinched shut again. File the cleat from brass and drill and countersink. The lamp socket and wiring are standard.

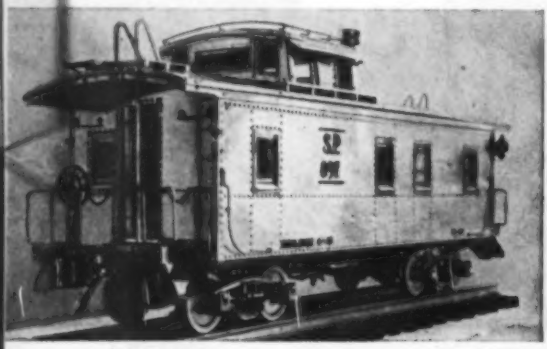

1/32" PINS
BRASS SHEAVE 1/4" x 1/2" D
Block
(2 REQ.)
1/32" x 1/8" BRASS
3/16" WHITE COTTON ROPE
PICTURE-WIRE STAY
3/8" SCREW EYE
TRUCK
TWO 1/16" HOLES EACH END FOR STAYS
1" R
3/8" R
1/2"
1" x 1 1/16"
3/8" SCREW EYE
BOOM - 9 1/2" OVER ALL
CROSSTREE
7/8" D.
CARTRIDGE-FUSE FERRULE
1/2" D
5/32"
1/4" HOLE
END OF BOOM
FILE FROM 1/2" ROD
Boom Socket
DRILL FOR COTTER PIN
1/8" D. x 7/8"
BOOM SOCKET
GOOSENECK
BRASS GROMMET
13 1/4"
DRILL & CTSK
DRILL 7/64"
1/4" HOLE
DRILL 5/32"
Cleat
Gooseneck
3/8" HOLE
CLEAT
SAW AT 2° SLOPE
11/16" R
4 1/2"
3 1/2"
1/8" x 3" PIPE NIPPLE
3/8"
2 3/8"
1/4" SCREW EYE
PICTURE HANGER
1/2" SQUARES
7/8" R
2" R
3/8"
5/8"
Crosstree
BASE
kingdon

CRAFTSMEN at WORK

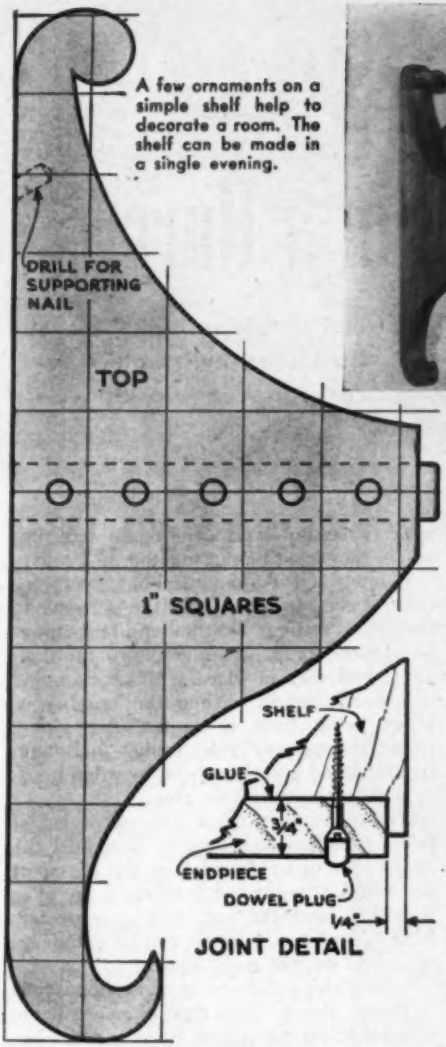
HOME-BUILT HYDRAULIC PRESS. Using surplus airplane parts, Wat Slee, of Seattle, built a two-way hydraulic press for inserting and removing bearings, bushings, and the like and for straightening and bending jobs in his home workship. With 4 sq. in. of piston surface in his cylinder, he has a 4-ton press using 2,000 lb. of oil pressure from a 1" bore hand pump.

THREE-MASTED SCHOONER. This model of the old *Hartford* was made by Paul Chamberlin, of Alhambra, Calif., from PSM plans. Work was almost entirely by hand, the only fittings purchased being the deadeyes, blocks, anchors, and belaying pins. The guns were turned from brass and electroplated black for a realistic appearance.

MODEL CABOOSE. Like the postman who hiked in his spare time, Engineer Jack M. Fesco, of the Southern Pacific, worked on his model caboose. Made on a scale of ¾" to 1', it is complete in every detail including inside fittings. Parts were put together with 3,000 rivets and 1,000 screws. The job took 4,850 hours. Fesco plans to work on a locomotive next.



GEARLESS SCOOTER. Hydraulic linkage between the ¾-hp. engine and the drive wheel makes gears unnecessary on this scooter built by Cpl. E. C. Cole, of Lost Hills, Calif. The scooter has two speeds, gets 70 miles out of a gallon of gas, and will carry three men, with sidecar, at 35 m.p.h. It will speed up to 45 m.p.h. when not taking the two passengers.



A few ornaments on a simple shelf help to decorate a room. The shelf can be made in a single evening.

Wall Shelf for Knickknacks in Colonial Style

For a home with early American furnishings and old-time knickknacks to display, this simple shelf will add an authentic note. Centered over a low bookcase or other furniture, it takes the place of a picture.

Choose good wood, such as nicely grained pine. Clamp or tack two pieces together, lay out the end pattern, and bandsaw identical endpieces at one time. The 5½" by 24" shelf is cut to fit over the front edge of the endpieces and simulate dado joints, although the pieces are actually butt-joined.

A ¼" hole ½" deep is drilled on an upward slant near the top of each endpiece as a means of supporting the shelf. The supporting nails require exact placing in the wall, but this can be done by measuring with the shelf itself.

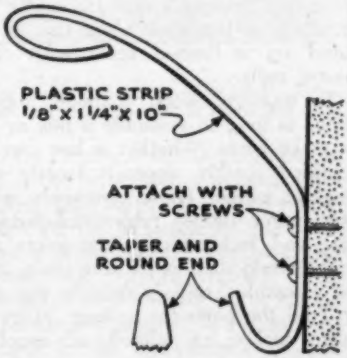
Sand the entire piece well. A first coat of linseed oil will impart a golden tone, if you like, or two coats of white shellac sanded and then waxed will do the job.

Hat and Coat Rack Bent From Plastic

Heated in the kitchen oven, a ⅛" by 1¼" by 10" length of clear plastic can be bent to shape for a modern hat and coat rack that can be attached to the inside of a closet door.

First, using a coping saw, taper one end of the coat hook, and smooth all edges with fine sandpaper. Then heat the piece in the oven at 250 deg. until it is pliable, take it out, and bend to shape with gloved hands. If the curves are not satisfactory, reheat and bend again. No jig should be necessary.

Finish by drilling and countersinking the piece for two wood screws to mount it by.



BOXES in a Hurry

Not simple to make, but still basic to many a project, boxes call for woodworking skill.

By JOHN P. ARNOLD

BOXMAKING on a production scale is a highly specialized branch of woodworking, and yet boxes are a basic form of so many projects that the home craftsman is often called upon to make them. Applications of the box structure range from hope chests to jewelry cases, and to such divergent things as newel posts, plywood suitcases, bookcases, cabinets, and other furniture. So if your hobby is woodworking, a look at small shop production methods may afford a valuable tip or two—particularly if you're interested in earning money in your shop, or in turning out projects in quantity for your gift list.

The machines usually available for the work are circular saws, jointers, shapers, and sanders. Dovetailing and lock-cornering machines of the kind used in box factories are too specialized and costly for the small shop, but their work can be duplicated on a limited scale with common power tools.

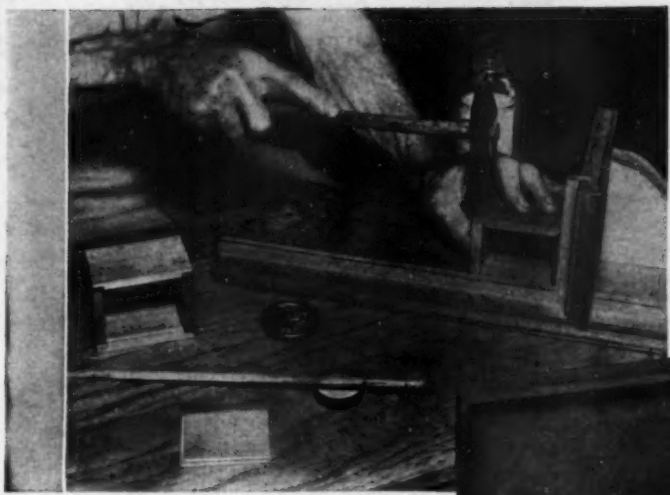
In quantity work, it takes about five times as long to assemble a box as it does to make parts. Whether a box can be assembled readily depends largely on the kind of joints. Those commonly used are butt, miter, rabbet, rabbet-and-dado, dovetail, and lock-corner. Butt joints are for rough work, such as packing cases, and can be assembled rapidly only in jigs devised to hold the parts for nailing. Miter joints, plain, locked, or splined, are excellent in appearance, but even when made with precision, they can't be put together in a hurry.

Rabbet and dado-and-rabbet joints require special forms to hold the parts while the glue is setting. Dovetail and lock-corner boxes need only be squared up, for their joints will stay in place without clamping if properly made. When the number of boxes being built is limited and gluing forms are not available, rabbet joints can be assembled with fair speed by using brads or nails with or without glue.

There are also three general styles of boxes classified according to their lids: the slide-cover or unhinged box; the cut-apart lid, which is separated from the body after assembly; and the box with a separately built hinged top. Details can be combined or varied to suit most jobs.

A box with a slide cover and rabbet joints is shown above. This type of construction is suitable for instrument cases and the like where nice appearance is not the main thing. Its chief virtues are the avoidance of hinging and a dustproof lid.

Stock for the sides and ends is ripped to width and grooved to take the slide cover. The stock is next cut to length, thus leaving each piece grooved right across from edge to edge. One endpiece is cut down to the bottom of the groove to take the lid. Then the sidepieces are rabbeted with a sharp dado head to the same depth as the groove. It is usually advisable to cut the rabbets a trifle wider than the thickness of the end stock and to sand them flush after assembly.

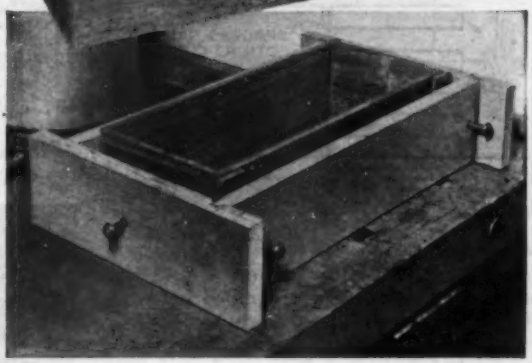


Squareness of assembly is assured when the sides and ends are glued up and nailed while held in a jig consisting of a braced upright at right angles to a flat base. The brads hold rabbeted corner joints and eliminate the need for clamps.

Boxes with tops like that below are made as closed units and then sawed apart to form body and lid. This construction along with a dado-and-rabbet joint, also shown below, makes fine-looking boxes.

If the quantity of boxes is limited and gluing forms are not available in the right size, the parts can be assembled with glue and light brads. A convenient jig for holding the parts square when nailing is shown in use above. Particular care must be taken to get the lid grooves in alignment.

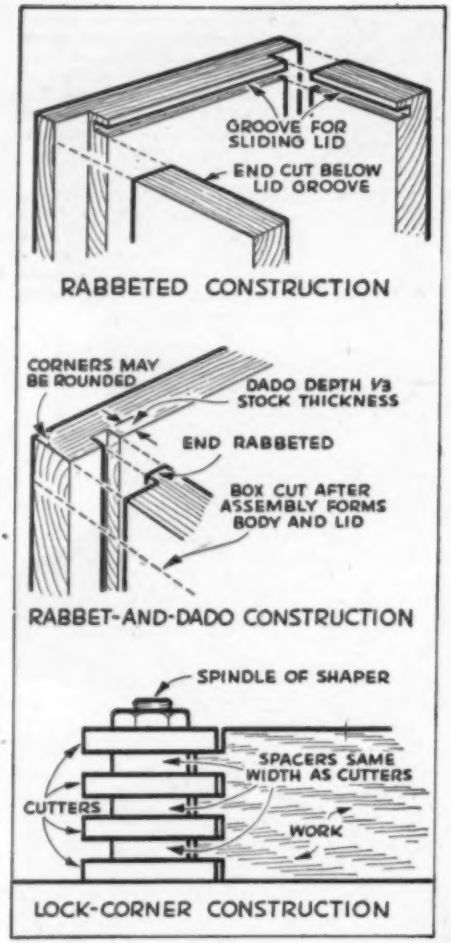
The lid treatment shown on the facing page is somewhat elaborate. Though rabbeting the three sides of the lid that go in the grooves presents a neat appearance, it is simpler to make the grooves wide enough to take the full thickness of the lid. Instead of the raised cleat at the end for opening, a notch cut in the upper surface will serve as a finger catch. The bottom of boxes like this, incidentally, can also be inserted in grooves cut as for the lid, or else simply butt-nailed to sides and ends with or without gluing.



An efficient clamp for gluing dado-and-rabbet joints applies pressure at the corners and ends. Wedges or screws are used.

An all-glued box having dado-and-rabbet joints and a cut-apart hinged lid is shown at center above. This is the best construction for novelty boxes of fine appearance when the quantity is sufficient to justify preparing special gluing jigs of the kind illustrated just under the box.

The joints are cut in the usual manner on the circular saw or shaper, or the saw may be set up to cut the dado and the shaper to form the rabbet. Make the dado one third the thickness of the side stock so rounding of the corners after assembly will not weaken the joint. Dado-and-rabbet joints are ideal not so much for the additional gluing surface they provide as for making clamping more convenient. They are not suitable, however, for boxes having bottoms inserted in grooves, as the grooves would have to be end-stopped on the



dadoed pieces so as not to show. The simple rabbet joint with the groove cut to the depth of the rabbet as described before is by far the best for inserted bottoms.

Glue up the sides and ends in jigs made of hardwood, accurately squared, and used on a flat surface. These forms should be sufficiently oversize to take wedges or screws (thumbscrews are best) to clamp the joints.

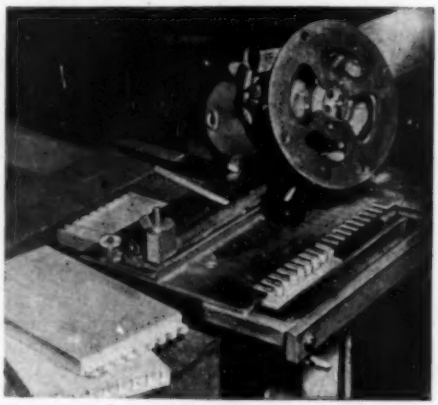
How long the boxes should remain in the forms varies with the material, its freedom from warping, and the kind of glue used. With fast-setting hot glues under favorable conditions, the jigs can be removed in 15 minutes and the boxes set aside for further drying. Squareness and intimate contact of the gluing surfaces, rather than great pressure, should be sought. Mahogany and other nonwarping woods require minimum clamping; oak, walnut, and the like take a little longer. Filler blocks of suitable size may be inserted in big forms for clamping smaller boxes.

Tops and bottoms are cut 1/16″ oversize to allow for possible slipping under the clamps. They may be glued to the boxes and the latter stacked and held under weights or clamped several together with bar clamps.

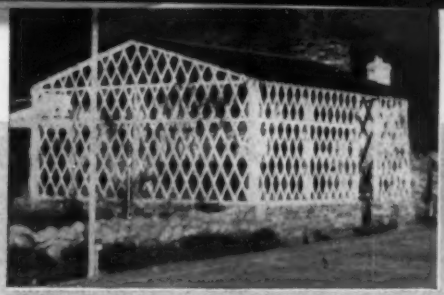
Dovetail joints can be made with reasonable efficiency in limited quantities. A high-speed router with a dovetailing attachment will cut both members of a joint in one operation. The setup, shown below, requires careful adjustment for thickness, but once it is made, no skill and little effort is needed in cutting either open or blind lapped dovetails. The stock may be ¼″ to ¾″ thick and up to 8″ wide. With systematic laying out, the four joints of a box 6″ deep can be cut in about six minutes.

Lock joints 2″ or 3″ in width can be cut on a shaper by loading the spindle alternately with cutters and spacers of identical width. The fence is set at a point where the cutters will work to a depth equal to the thickness of the stock. Ten to 15 or more box sides may be clamped together or held in an open-box jig for cutting joints at either end with one passage.

The endpieces are cut the same way, but the spindle is raised or lowered so the grooves and pins mate perfectly with those of the sides and still allow the bottom and top edges to be flush all around. END



Once the setup is made on the router, either open or blind lapped dovetails can be cut with little effort. Both members are cut in one operation.



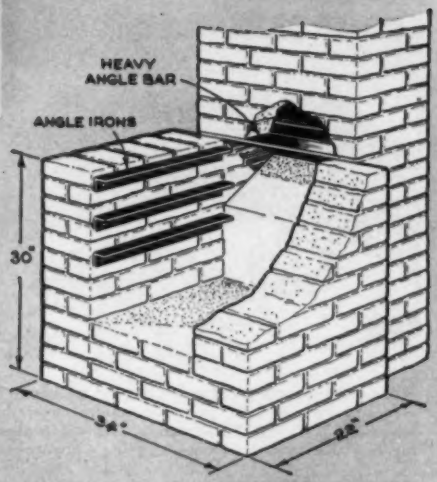
Outdoor RUMPUS ROOM

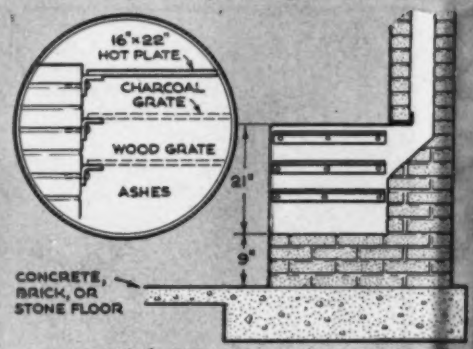
IF YOUR outdoor stove is put under a roof along with an airy playroom, neither hot sun nor rain can spoil your back-yard or lawn parties. Lattice provides a cool, open finish, strengthens the structure, and serves also as a trellis for growing vines. If mosquitoes or insects are a problem, screened frames may be installed also and the gable ends closed.

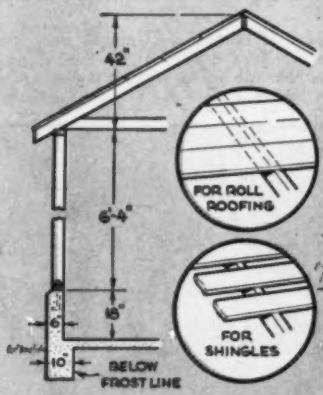
Field stone, brick, or concrete may be used for the floor and low foundation. Excavate below the frost line for the footings and barbecue foundation. Sills are held by anchor bolts set in concrete.

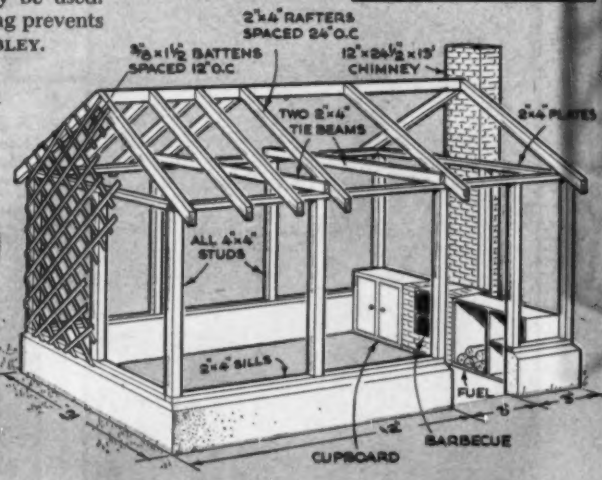
The brick barbecue is built conventionally with angle bars supporting the grates and hot plate or grill. One grate is for charcoal and a lower one for wood or coal. The chimney is built on the outside.

Shingles or roll roofing may be used. With the former, open sheathing prevents dampness and rotting.—HI SIBLEY.





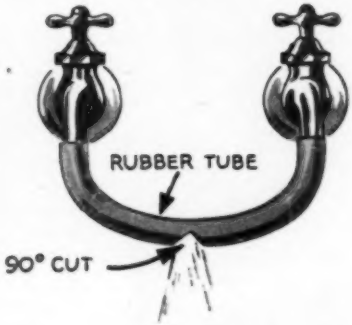




KEEPING the HOME SHIPSHAPE

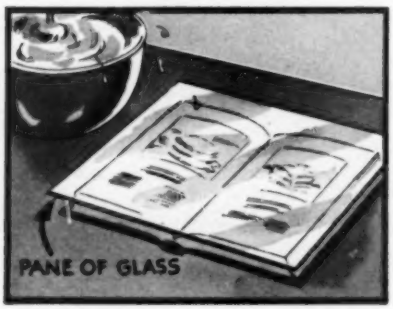
After papering the room in which your telephone is located, use scraps of the wallpaper to cover the telephone book, front and back. This will protect the book and give it a more pleasing appearance.

Ice-cream sticks carefully glued together as seen above will give you a convenient flower-pot stand or a coaster for a hot plate. After the glue has dried, stain or paint the stand as desired. Small brads may be used in place of glue if you wish.



When no mixer is available to give you water at the temperature you desire, slip a short piece of rubber tubing over the hot and cold faucets, cut an opening in the tubing at the middle, and adjust the faucets as necessary.

A pane of window glass placed on a cook-book will keep it open at the desired page, allow full visibility for reading the recipe, and save the book from any harmful spatterings.

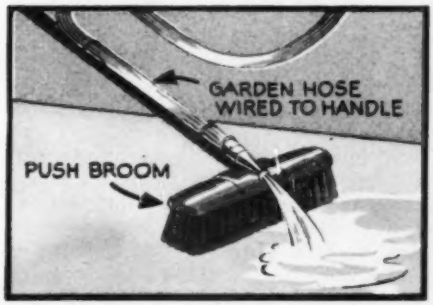


Small leaves or stones often slip through the teeth of an ordinary rake. You may catch them by attaching a strip of ¼" hardware cloth, allowing the teeth to project about ½".

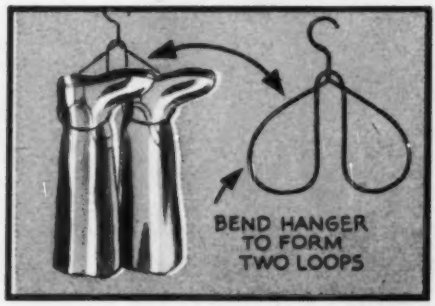
Most grass-cutting shears spread too far apart when pressure is released. The outward travel of the blades can be restricted by looping coat-hanger wire around them as illustrated here. One blade moves freely inside the loop.

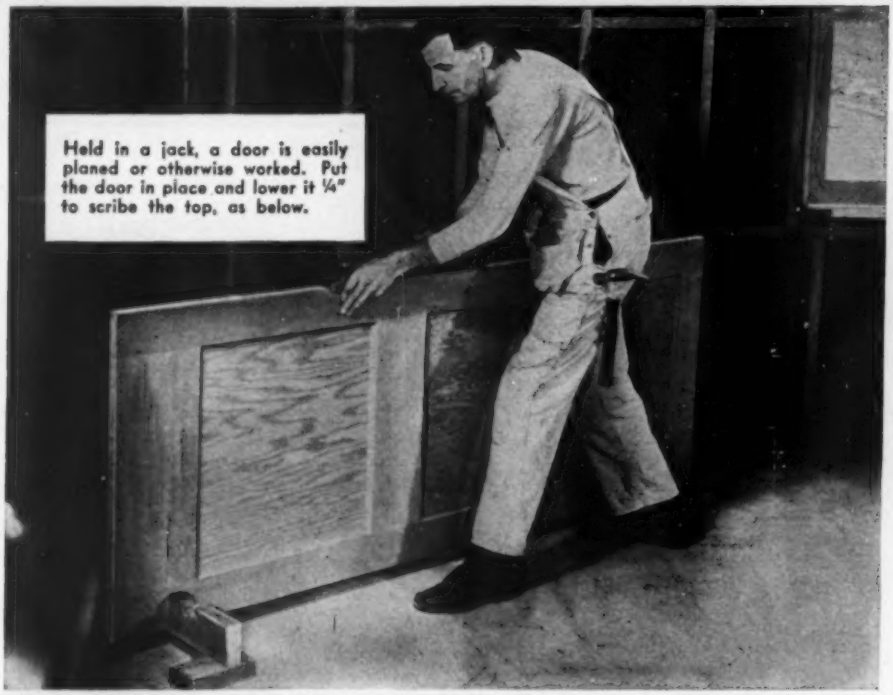
Screens rigged up as shown above can be rolled into compact bundles for winter storage. Sandwich the ends of each length of screen between wood strips and lap the edges between narrow wood uprights.

If a concrete floor, driveway, or sidewalk needs cleaning, a garden hose wired to the handle of a push broom will enable you to accomplish the job with about half the effort. To clean out cracks, turn the nozzle to give a high-pressure stream.



Rubber boots with flexible tops that collapse when the boots are not being worn can be properly dried and ventilated by suspending them upside down on a special hanger formed by bending two loops in an ordinary wire hanger. This allows air circulation.





Held in a jack, a door is easily planed or otherwise worked. Put the door in place and lower it ¼" to scribe the top, as below.

Fitting DOORS

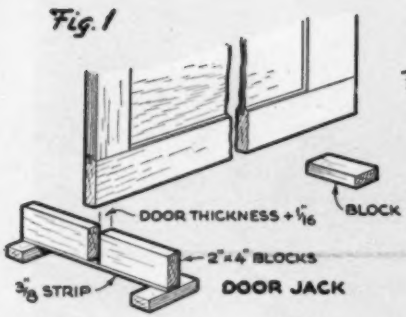
By EDWIN M. LOVE

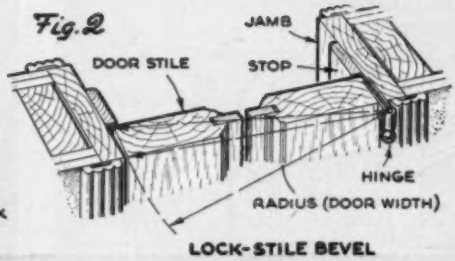
ON HOW doors are hung depends the service they will give—whether they will bind at the edges, have draft-inducing gaps, or fit snugly and open and close easily. The same is true of window sash.

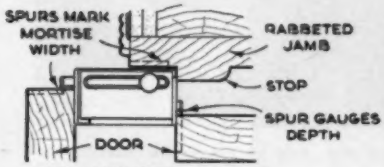
Select the best doors for the best rooms, carry them to their locations, and stand them on blocks. In preparation for hanging, sight along the stiles for spring. If there is an outward-sprung corner, make it the latch side so that it will be held in position by the latch. If the door frame does not have a rabbeted jamb, nail up blocks for temporary stops.

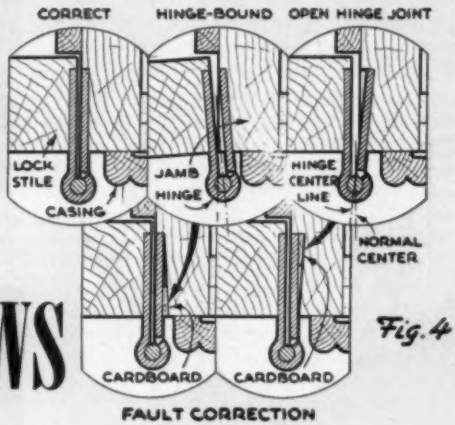
Make a jack like that in Fig. 1 to hold the door while it is being worked. The weight pinches the blocks against the door, holding it steady. Joint the hinge stile first, straight and square or very slightly beveled toward the stop to prevent binding.

Then stand the door in the opening, hinge stile against the stop, with the top held against the top of the frame by means of a large chisel on a fulcrum at the bottom. An auto-spring leaf is also handy for this since the ends will rock. Inspect the fit of the hinge stile against the jamb, and scribe for irregularities. Have a helper run a



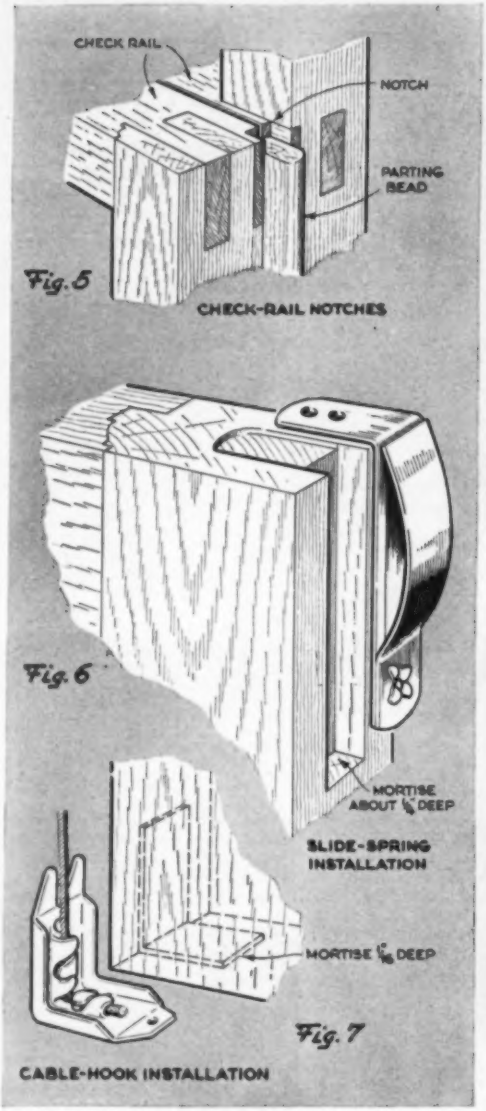






and WINDOWS

Mortise length is gauged with a leaf from the hinge, but width and depth are best marked with a butt gauge, which is used on the jamb at the same settings. Begin making the mortise with chisel cuts about 3/8" apart. Work inside the lines. Clean out the chips with the chisel lowered and its beveled side up. Drive the hinges in from the edge. Punch screw holes with a nail set, locating them toward the back of the leaf holes to draw the hinge back when the screws are driven.



Nail the slide spring in its mortise, but leave the nail heads projecting to permit removal if the spring needs adjusting.

Drive the cable hook into its mortise from the side of the sash to sink the flanges, and then put the nail in from below.

pencil along the lock jamb on the other side to scribe the lock stile.

Plane to the lines so the door will have about 1/16" clearance at the edges and top. Give the lock stile a bevel toward the stop side (Fig. 2). Stand the door in the frame again and inspect the top fit, dropping it about ¼" for convenience in scribing.

Mark the hinge positions in pencil on the jamb 7" below the top of the door and 11" above the floor. Then stand the door in place, raising the top against a clearance gauge such as a cabinet scraper, and mark the hinge positions on the door and jamb at the same time with stabs of a knife.

Gauge the ends of the mortises with a hinge leaf, but use a butt gauge for width since it automatically allows for clearance against the stop of a rabbeted jamb, as in Fig. 3. Mark also for hinge thickness. Drive

With dividers set, the bottom of the lower sash is scribed to the sill. Mark the edges with a bevel at a slightly greater angle than the sill slope.

Notch the parting bead to clear the spring balance and nail the balance in the pulley-stile opening with four nails driven in cleanly.

the hinges in the mortises from the edges if they fit snugly. Punch screw holes with a nail set placed a little to the back of the hinge-leaf holes.

To swing the door, mesh the halves of the lower hinge, start the pin, and then engage the halves of the upper hinge. If they are slightly offset, tap them up or down with a hammer. With the hinge stile properly jointed and the hinges set flush, the door should close perfectly. If it is hinge-bound, place cardboard behind the leaves mortised too deep, as in Fig. 4. A striking lock stile is sometimes remedied by jointing while the door is on the hinges, but only if hinge-stile clearance is correct.

Customarily the lower end of the door is cut ½" above the finish floor, an operation usually deferred until the finish floor is laid and the door can be scribed.

When hanging windows, install upper parting beads permanently, but only fit the side beads and leave them out for the time being. Joint the sash stiles, reducing the width of the sash to about 3/16" less than that of the window frame. Notch the check rails, as in Fig. 5, to clear the parting beads, and insert the slide springs temporarily in the upper corners (Fig. 6) opposite the sash balance. If necessary, joint the check-rail faces for clearance.

Set the upper sash in the frame and hoist it to the top to check and fit the top rail. Lower it to the bottom and install the side parting beads by slipping the lower ends into the grooves past the check-rail notches while springing the upper ends to clear the top of the frame. When the ends touch the sill, the beads can be forced full-length into the grooves. Try the sash for bead clearance and hold it at the top with a nail.

Next, set the lower sash in place, wedging the bottom, if necessary, to parallel the check rail with that of the upper sash. The projection above the upper-sash check rail equals the strip to be cut from the bottom rail of the lower sash. Set scribers or dividers to this amount and mark at the sill.

Remove the sashes and mortise the lower end of the stiles to receive the balance cable hooks, as in Fig. 7. When the spring sash balance is taken from the package, the cable hooks will be reversed. Pull them down slightly and turn them out before nailing.

Put the upper sash back in the frame and swing the cable edge out. Pull down the balance hook, insert it in the mortise, and swing the sash back against the blind stop. Hoist it and try the action. Binding may be due to too much slide-spring projection, while sagging of the opposite side may indicate the slide-spring mortise is too deep. The former is remedied by deepening the mortise, the latter by cardboard shims. Since the spring balance closes the parting-bead slot, the bead must be notched to clear.

Hang the lower sash in the same way. Prime sashes soon after hanging. END.

WHAT'S YOUR INGENUITY QUOTIENT? IQ

IT'S AN ART to quiet a bawling baby. When the kid I was watching yowled, I soothed him by taping cutouts to a phonograph and projecting moving pictures onto the opposite wall with the beam of a flashlight.—HOWARD JOHNSTON, JR.

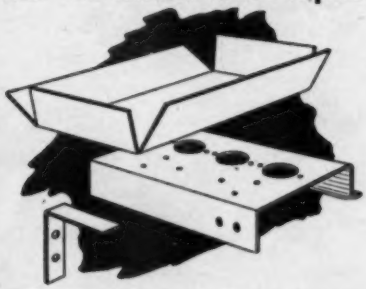
THE NOSE KNOWS when the water pan of a hot-air furnace runs dry. I kept forgetting to fill the pan until I hit on the idea of placing one or two moth balls in the pan. When the water evaporates, the moth balls start to do likewise. The scent is sent up the register, sending me trotting down with a bucket.—RONALD EYRICH.

I FOUND THE $64 ANSWER to the question that's been bothering everyone. After locating a puncture by holding an inner tube under water, I mark the spot with my new underwater ball-point pen so that I can find it again when I come up for air and a tire patch.—KENNETH MURRAY.

Have you pulled off a smart one lately? We will pay for acceptable contributions showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.

WATER, WATER, EVERYWHERE, but nothing with which to pour it into our car's hot and thirsty radiator. I pried off a hub cap that had just been coming along for the ride, scooped up all the water old rubberneck could drink, then cleaned the cap and took a good, long swig myself.—ROBERT M. KAHN.

Homemade Brake Makes Accurate Bends for Metalwork Projects



CRAFTSMEN who work with sheet metal know how stubbornly it can refuse to take a clean, sharp bend where the layout line demands it. A bending brake is the answer, of course, but they're usually thought to be difficult to make or expensive to buy. This one is neither. It was built in less than an hour from scrap wood knocked from an orange crate—all but the radius bar, which is oak. An old table leaf might furnish that. It handles aluminum up to 7" wide and .040" thick, and if you make it entirely of oak, it will handle heavier stock.

The base is clamped to a bench or bolted in a permanent setup, so be sure to countersink the radius-bar bolts on the underside. To use, simply clamp the metal under the radius bar and fold the leaf up and over. Make several trial bends on scrap first, noting how near the layout mark the bend actually comes. The radius bar should be beveled to compensate for springing back of the metal, which may be as much as 10 deg. for a right-angle bend. A separate 30-deg. bar will come in handy for special bends.

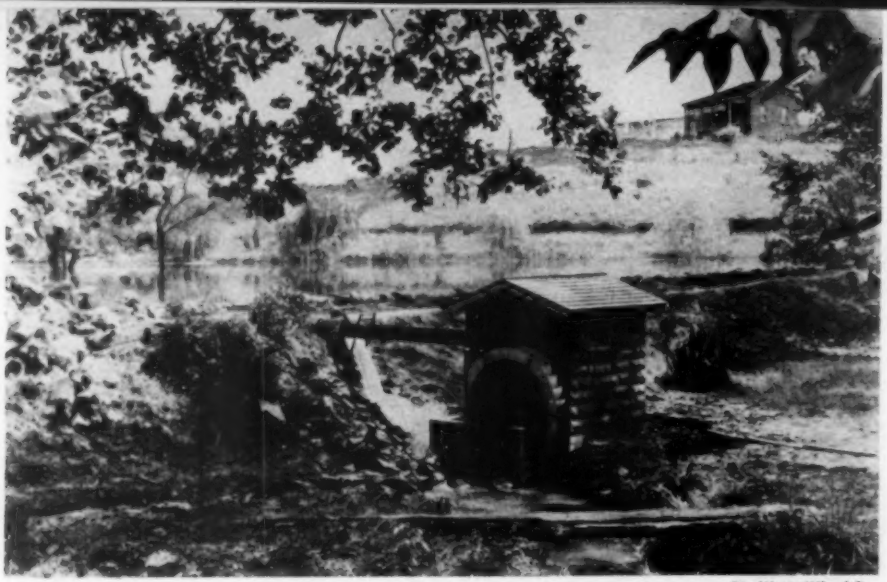
A great deal depends on the sturdiness of the hinges, so be sure to use a strong pair and attach them firmly. They must also be properly aligned to assure a free, swinging action of the folding leaf.

Wedge Screwdriver Grips Screw

WHEN a screw must be threaded into a tapped hole that can't be reached by hand, time will be saved if it is fastened to the screwdriver. This can be done by grinding down the blade of a long-handled screwdriver until it is about .005" thicker than the width of the screw slot, and then grinding a slight taper to form a wedge. Jam the blade in from the end of the slot so it will get a firm grip.—F. E. AVERILL, JR.

Shaping Brushes on Sandpaper

WORN brushes can be reshaped or special ones made to suit the job. Soak the bristles in water-soluble glue, shape to a compact mass, and let dry. Then rub on coarse abrasive paper to the form desired. Remove the glue in hot water.—WILL THOMAS.



Fitz Water Wheel Co.

Impounded by an earth-fill dam, water here drives an 8' overshot wheel connected to a pump. Sufficient power is secured, even during low water, to supply three homes with water pumped against a 258' head.

Your Own WATER-POWER PLANT

Want to put that brook to work? Here's the first of a series on how and where to engineer your own back-yard Boulder Dams

PART ONE

By C. D. BASSETT

MANY farms, ranches, and other fair-sized tracts of land embrace at least one brook within their limits. In most cases, the idea that a small stream can provide a useful source of power has never occurred to the property owner or, if it did, has been rejected as silly. The fact remains, nevertheless, that impressive advantages can spring from small water-power installations.

Electricity can be generated for general use, for pumping water, and for stand-by or emergency purposes; and the pond that is usually created can serve additionally as a means for watering livestock in dry times, for fire-fighting, as a swimming pool, as a place to raise fish for sport or as a "crop," and for landscaping or scenic purposes.

Power can be obtained from any flowing stream, no matter how small. Whether it is desirable to harness this power depends on two factors. First, does water flow all the year round, even in the late summer months? Second, does enough water flow to make the harnessing of it economically sound? The first factor is, of course, known to the property owner by observation; the second may be determined by simple measurements.

What's the least amount of power that is worth developing? There is in this country at least one water-wheel manufacturer who makes a line of small-capacity units, and this company's smallest hydroelectric unit develops ½ kilowatt. From this it can be inferred that, in this company's experience, it is not economically wise to harness a stream that will not develop at least 500 watts dependably at the switchboard. Half a kilowatt will light 10 fair-sized lamps or supply ¾ hp. to operate, say, a deep-well pump. With this figure in mind as a criterion, the reader can make a preliminary reconnaissance of the water power available on his property. The chances are he will be surprised; even a seemingly insignificant

stream can deliver many times this minimum.

The power available at the site of a water wheel (that is, before deductions for inefficiencies in the wheel and generator) is expressed in this formula:

$$\text{Hp.} = \frac{62.4 \times Q \times H}{33{,}000}$$

Here Q is the cubic feet of water passing through the wheel in one minute; H is the "head" or vertical distance in feet through which the water falls; 62.4 is the weight in pounds of 1 cu. ft. of water; and 33,000 the number of foot-pounds per minute in 1 hp. A number of methods exist by which the variables Q and H can be determined, but before considering them, it's well to examine first the possible sites for the dam and wheel, since they will necessarily affect the amount of head secured.

The location of the dam, as suggested in Fig. 1, should be governed by two principles. It should be placed where the greatest useful head is obtainable, that is, where the greatest

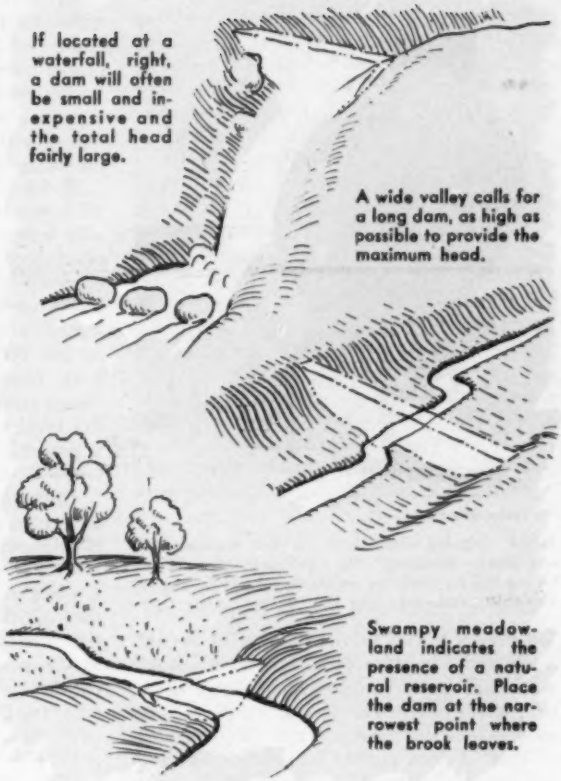
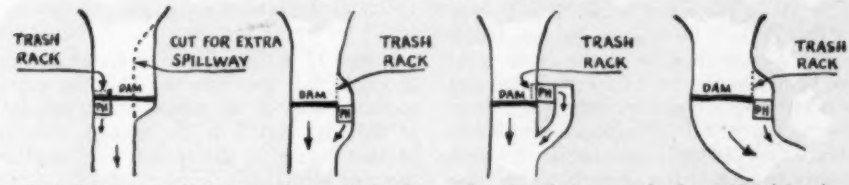
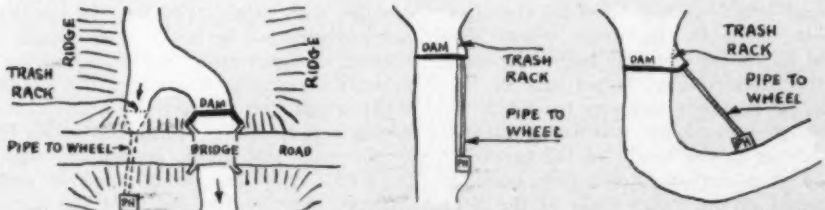


FIG. 1. LOCATING THE DAM

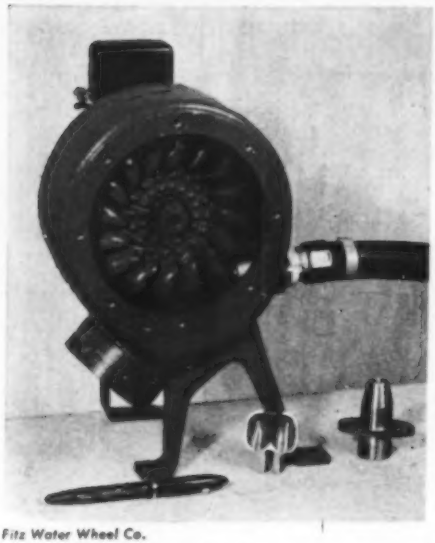
FIG. 2. LOCATING THE WHEEL



Typical layouts with the powerhouse at the dam, a location that uses only the artificial head.



Typical "divided-fall" layouts, with the wheel below the dam, which add the natural to the artificial (dam) head.



Fitz Water Wheel Co.

This 4" impulse wheel, built for war requirements, was direct-connected to a small generator. It can be run off an ordinary water faucet. Note the removable nozzle and the tiny bucket, lower right.

fall occurs in the shortest length of stream. Such a site is often indicated by a natural waterfall, by a conspicuously steep slope, or by the swiftness of the current. The second locating principle is a simple matter of cost: a dam should be placed where it can be smallest and still impound the most water. This means, in general, that it should be placed where the stream valley or cut is narrowest.

The site of the water wheel, Fig. 2, may be either at the dam or some distance below it. The former location is the more common, being simpler to build and eliminating the need for a pipe or penstock to deliver water to the wheel. Disadvantages include the fact that the spillway must be of ample capacity to protect the powerhouse in time of high water, and the fact that only the "artificial head"—that created by the dam itself—is available. In cases where the ground falls away abruptly below the dam site, the "divided-flow" layout may be desirable, for it greatly increases the head.

Another preliminary calculation should be made as to the height of the proposed dam. This is restricted, as a rule, only by the height of the valley walls at the site, and by the materials, equipment, and money available for building it. The higher it is, the greater the head and the larger the pond that will be created. "Pondage"—water stored for use in times of peak demand—is an important factor in water-power calculations. Power is rarely needed 24 hours a day, and construction of a dam of sufficient height to provide water storage will greatly increase the power available at the time of day required.

If, for example, a wheel is to be run for 16 hours a day, and if a dam is built that will impound all water flowing into the pond during the idle eight hours, the power capacity will be increased by 50 percent. Don't neglect to distinguish between "live storage"—the volume of water represented by the difference in height of the spillway flash boards and the wheel intake—and "dead storage"—the volume of water below the level of the wheel intake. The former is power banked against a time of need; the latter is worthless, powerwise.

Once the dam and powerhouse are tentatively sited, and the height of the first is provisionally set, it is time to measure the power available. Assume that all water flowing in the stream can be made to flow through the wheel, which is a fair assumption on small installations. This flow (Q in the power formula) can be determined by the "weir method," which involves constructing a temporary dam of controlled proportions and which will be detailed in a subsequent installment, or by the "float method," which is theoretically a trifle less accurate, though still quite satisfactory.

The float method' (Fig. 3) involves the formula:

$$Q = A \times V \times 60$$

in which Q is the volume of water flowing in cubic feet per minute, A is the cross-sectional area of the stream in square feet at the site, and V is the average velocity of the stream at this point, expressed in feet per second.

Select a length of the stream that is fairly straight, with sides approximately parallel, and unobstructed by rocks or shoals for a distance of about 100′. Stretch a taut wire squarely across the stream near the middle of this length and measure the width of the stream here in inches. Mark this width off on the wire and divide it into ten equal divisions. From the center point of each division, measure the depth of the water in inches. Then average the depth figure by adding each value and dividing by 10. The cross-sectional area of the stream, A,

is now secured by multiplying this average depth by the width, and dividing the result by 144 to obtain the answer in square feet.

Your next step in determining Q is to measure the rate of flow. Using a steel tape, mark off a course along the bank that is 100′ long; the mid-point of this course should be at the line where the cross section was measured. Stretch wires or rope tautly across the stream at each end of the course, and make a float by filling a bottle so that it rides awash. Provide it with a pennant so that you can follow it easily. Then set the float adrift in the middle of the stream, timing its progress over the course with a stop watch, beginning just when the pennant passes the first wire and stopping just as it passes the second.

Make a series of runs, averaging the results. The speed of the float in feet per second is then the length of the course divided by the average time. This result is not, however, suitable for immediate use in the flow formula, since not all the water in a stream flows as rapidly as that in the center and near the top. If you multiply the float speed by the coefficient 0.83, the resultant value will serve as V in the flow formula.

Given an estimate of the amount of head to be present at the wheel, you can now make a rough determination of the horsepower your stream can provide. It's worth emphasizing, though, that this figure is necessarily only as accurate as the measurements that produced it, and that the power indicated is that present *at the time of measuring*. A single stream-flow value is not of itself particularly useful unless it is obtained at the time of lowest water, usually in the late summer months. Moreover, even if you have measured the flow at slack-water time, the figures should if possible be supplemented by others secured during maximum springtime flow, so that you can calculate the size of spillway needed to prevent damage to your installation in times of high water.

It's a good practice, for back-yard engineers as well as for professionals, to refine, cross-check, and test your measurements by all means at your disposal. Such checks will not only reduce the chance of disappointment in the final result, but will also permit calculated economies in construction and greater efficiency in operation.

Your estimate of the head present at the wheel, for instance, should be carefully checked, since head is a vital element in the efficiency of any water-power project. Several methods for determining the head rather precisely will be given in the next installment, together with the weir method for measuring flow. Subsequent installments will consider types of dams, methods of construction, wheels best suited to small plants, and plans for building them.

Before you begin even a preliminary reconnaissance of water power on your property, the writer suggests you secure a loose-leaf notebook to be devoted solely to the project. Develop the habit of neatly entering all data as it is obtained, not forgetting to note dates and stream conditions at the time measurements are made. Such a record is a great help in performing sound calculations and producing excellent results.

TO BE CONTINUED.

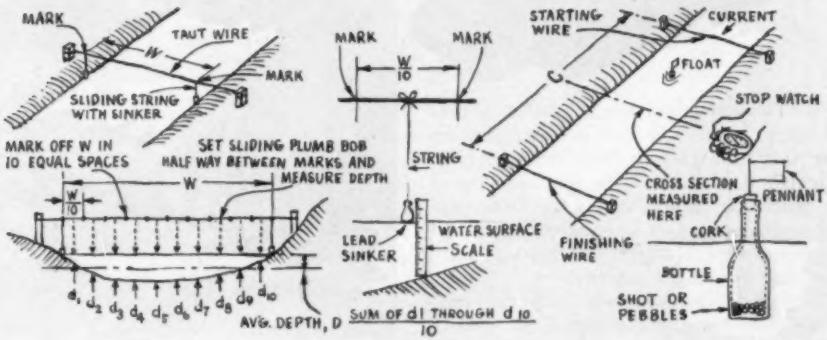


FIG. 3. FLOAT METHOD OF MEASURING FLOW

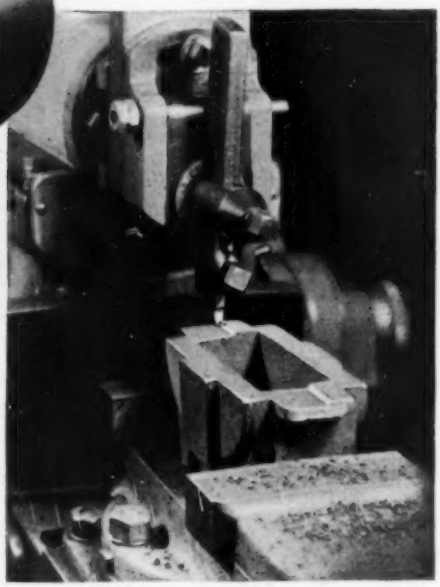
Vertical STEAM ENGINE

AMATEUR machinists who run the models they build will get double pleasure from this miniature vertical steam engine. Although it is not a scale reproduction of any particular engine, it has the same general appearance and eye-taking appeal of the picturesque old-timers so hard at work about the turn of the century.

The model is equipped with the link-motion reverse gear perfected by George Stephenson for his famous locomotive, *The Rocket*, in the 1830s. This valve action, which also provides a variable steam cutoff, has played a historic role in steam-power development. The engine is a double-acting noncondensing one that exhausts directly into the air with the familiar *puff-puff* of a donkey engine or steam shovel.

With its 1¼" cylinder bore and 1" piston stroke, and with 75 or 80 lb. of steam in its boiler, the little engine will turn over at 1,500 r.p.m. Actual power will depend much on the boiler used and on the workmanship in the engine itself. The design is for heavy duty, however, with main bearings and other working parts larger than scale, and the engine will stand up well under hard, continuous runs at full working load, developing enough power to drive a quite large model boat, a small dynamo, an air fan, or other light equipment of fractional-horsepower rating.

Much exacting work is required in building an engine of this type, espe-



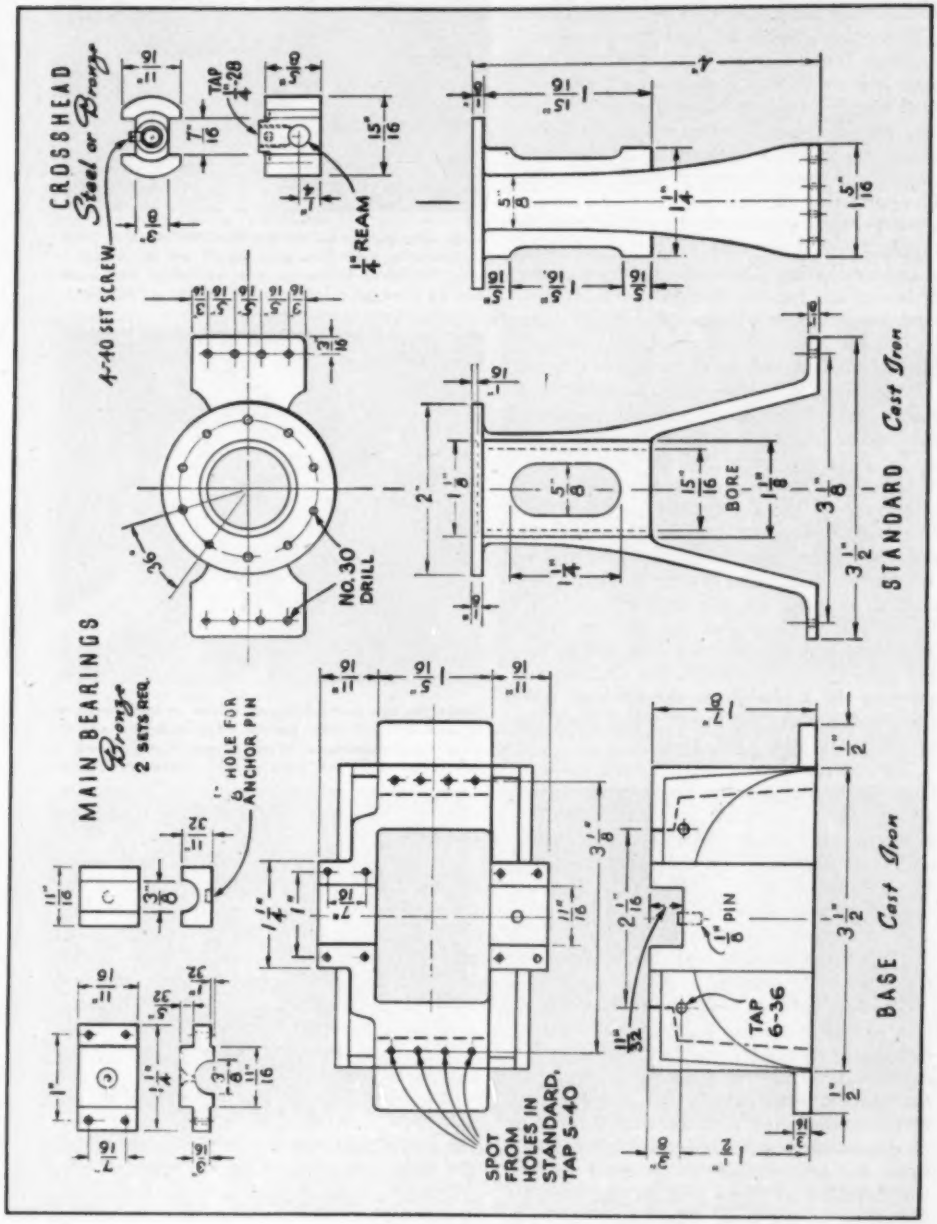
Machining the bottom of the casting for the base. The operation can be done in a lathe as well as a shaper, with the work clamped to the faceplate.

with Reverse Gear

PART ONE

By

C. W. WOODSON



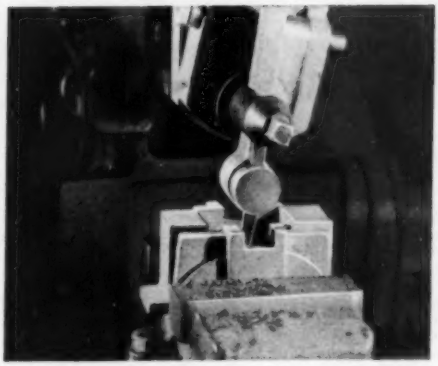
cially since the reverse gear and crankshaft, to be described in a later installment, and other small parts must be machined from steel. However, it is enjoyable work for the modelmaker, and it is of a kind well within the scope of anyone who has become proficient in the use of a screw-cutting lathe.

If you are experienced in woodworking, you can build the necessary patterns and have iron or bronze castings made at your local foundry for the base, standard, cylinder, cylinder head, steam chest, and flywheel. Or you can even make up the sand molds and pour bronze castings yourself. The pattern work, however, is by no means a one-evening project, and castings can be supplied for those who want to get right at the machining. Dimensions shown in the drawings are for the finished parts. If patterns are made, an allowance of 3/32" must be added to surfaces to be machined. Shrinkage allowance need not be considered.

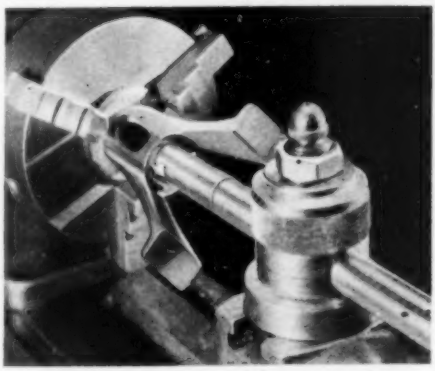
Machining operations are possibly best begun on the base since many of the parts can be fitted on it and temporarily assembled as the work proceeds. The casting is easily handled in a shaper, but if your shop boasts only a lathe, the facing can be done with the work clamped to the faceplate and the milling can be done with the lathe milling attachment. Since the casting is open at the center, only the bottom and top need be faced and slots milled for the bearings, after which the pin holes are drilled and the piece cleaned up with a file. Drilling and tapping the screw holes should wait until the mating parts are fitted, when both can be drilled at the same time.

Two identical main bearings are made up from ¾" by ¾" brass bar stock cut to length and soldered together in pairs. Mounted in the four-jaw chuck, each bearing is drilled and reamed to size for the crankshaft and the ends faced smooth. The halves are then melted apart and the parts filed to shape and to a good snug fit in the base. Save drilling them and the base for screws until the crankshaft can be set in place.

The standard or main column is held in the three-jaw chuck, and the solid body is bored smoothly and accurately to take the crosshead. With the piece on a mandrel, the head is faced square with the bore and turned to diameter; then the work is reversed on the mandrel and the feet are trued. Screw holes are next drilled in the head to hold the cylinder in place and in the feet for mounting on the base. The tapped holes in the base are spotted from those drilled in the feet.



Slots are machined across the top of the base to take the main bearings, which will be made a snug fit. If a shaper is not available, the work can be done on a lathe with a milling attachment.

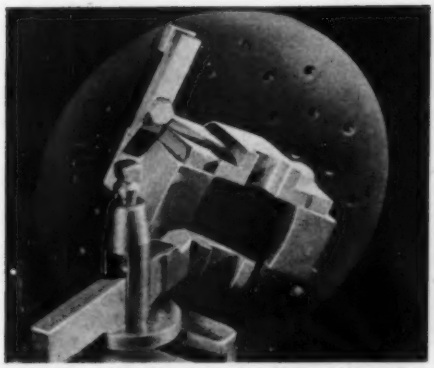


Since the top part of the standard or main column is cast solid, it must be drilled and bored out to take the crosshead. The operation is performed in the lathe with the work in the three-jaw chuck.

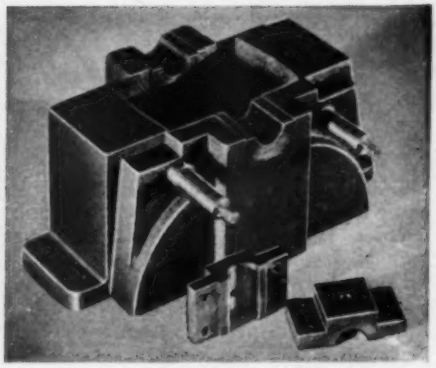
In making the crosshead, a short piece of cold-rolled steel or bronze is held in the three-jaw chuck and turned to a nice sliding fit in the main-column bore. Next, the upper end is recessed and turned to shape, and it is also drilled and tapped for the piston rod while still chucked so the outer diameter and the piston-rod hole will be concentric. The part is then cut off and the opposite end faced smooth.

Grooves are cut on both sides in the shaper or with the milling attachment, leaving a ¾" thick web to take the forked end of the connecting rod. The hole for the connecting-rod pin is then cross-drilled in the lower end.

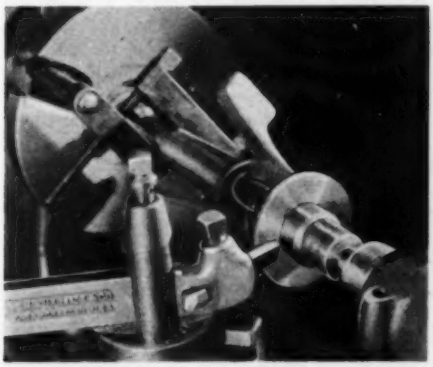
TO BE CONTINUED.



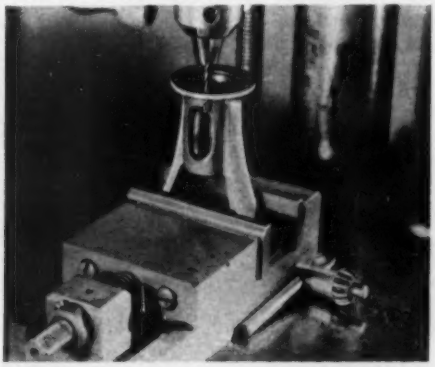
Here the base casting is clamped to the faceplate of the lathe, and the top is machined smooth and to height. A heavy cemented carbide tool is used. Any rough spots are cleaned up with a file.



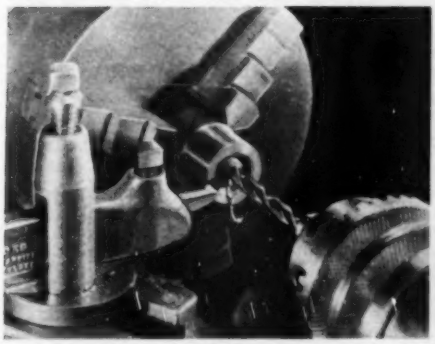
Halves for the main bearings are drilled and reamed while soldered together, then split apart and each half filed to shape. Here the lower halves are in their slots, the upper ones beside the base.



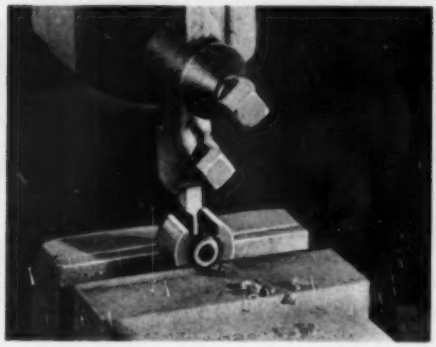
The column is then mounted on a mandrel held between centers for facing the head square with the bore and turning to diameter. It is next reversed on the mandrel and the feet faced smooth and true.



Drilling the head for screws to hold the cylinder in place, and the feet for four mounting screws apiece, completes the standard. Tapped holes in the base are spotted from those drilled in the feet.



Stock for the crosshead is turned to a sliding fit in the main-column bore; then one end is recessed and turned to shape. The piece is also drilled and tapped for the piston rod while chucked.



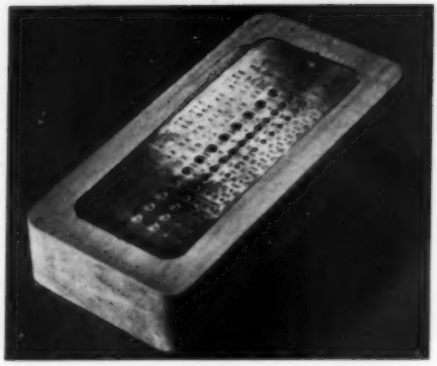
Grooves milled in opposite sides of the crosshead take the forked end of the connecting rod. This operation may be done in a shaper, as shown here, or with a lathe milling attachment.

NEW SHOP IDEAS

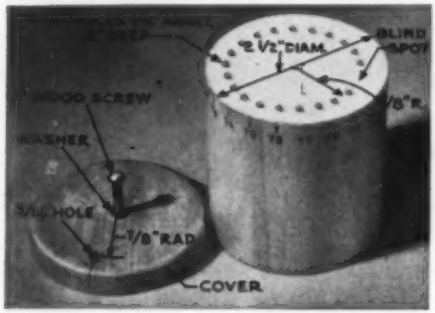
SPECIAL DRILL HOLDERS. Here are two easily made devices to help keep your drills in order. The circular container below serves both as a storage place and as a selector for drills between Nos. 61 and 80. At the right, a gauge is used as a stand for that extra set of high-speed precision drills which you want to give special care.

For the circular container, turn a piece of stock to a diameter of 2½" and drill a small center hole. Then cut off a ⅜" piece for the cover and enlarge the hole in it for a 1" roundhead wood screw. In the container, locate the radial holes exactly as indicated and drill 2" deep. They should be big enough to enable you to store several drills of each number.

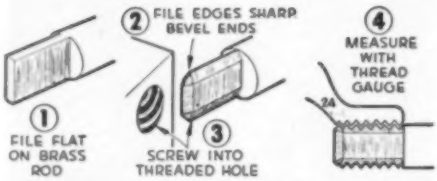
To make the gauge stand, cut a block of maple 1½" by 3½" by 7½" and slice off a ½"-thick piece for the bottom. Rout out the top to receive the gauge. Then, with the gauge in place, spot each of the 60 holes through the top. Next, remove the gauge and drill each hole oversize. After attaching the base, fasten the gauge to the block with two escutcheon pins.—H. R. PFISTER.



This holder, a drill gauge set in a wood block, provides storage for an extra set of precision drills.

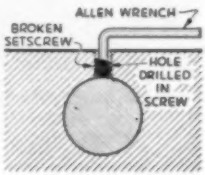


The 3/16" holes let you store several drills of each size in this container. To get a particular drill, turn the cover hole to the size you want.



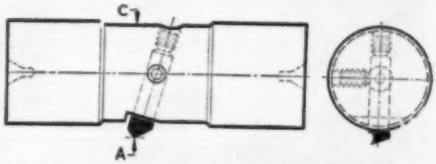
MEASURING A TAPPED HOLE. When a tapped hole is too small for accurate use of a thread gauge, obtain a brass rod about the estimated diameter of the required screw, file as shown above, and turn into the hole. This will cut threads into the sharp edges. Measure these with a gauge and refer to a screw-thread table for the hole size.

BROKEN SETSCREW REMOVED. A setscrew that has been twisted off in its socket may be removed by drilling a small hole in the broken part remaining in the socket, and then driving an Allen wrench into this hole. Drill the hole just a trifle smaller than the wrench. After the wrench has been firmly lodged in the hole, the broken part may be turned out in the same way that you would use the wrench normally. The wrench will not be damaged if care is used when forcing it into the hole.



MARK COMPOUND-REST TRAVEL. Witness marks placed to indicate the extreme travel of a compound rest, as at left, will tell you if the rest should be moved before starting a new cut. This will save you the annoyance of "running out of travel" in making an important cut—EARL R. GODDARD.

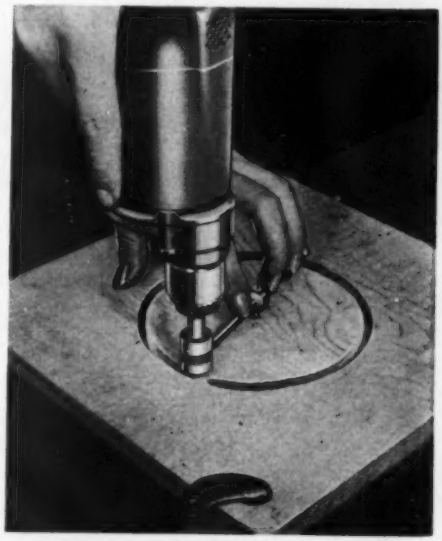
IMPROVED BORING BAR. With this boring bar, the cutter may be set quickly and accurately to bore an exact diameter. Center up the bar and turn down a section at the cutter location, enough to run true. Drill the cutter hole at an angle of about 70 degrees, and only about three quarters through the bar. Drill the rest with a tap drill and tap to receive a short headless setscrew of a diameter less than the cutter to be used. Then drill and tap a second hole at right angles to the first to receive another setscrew for pinching the cutter in place.

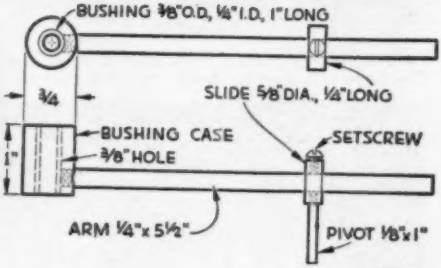


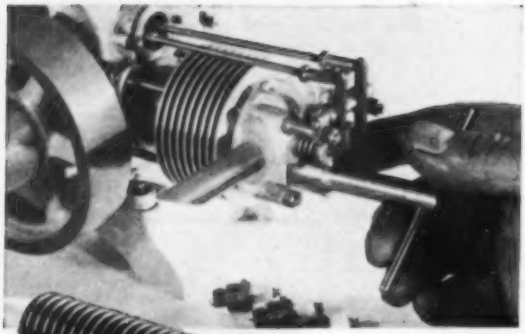
To set the cutter, add the diameter of the turned-down section and the diameter to be bored. Then adjust the cutter so that a measurement taken over the bar and the cutter point, across A-C in the drawing, equals half the sum obtained.—J. S. MORREL.

CIRCLE CUTTER. Constructed of drill rod, this tool will enable you to cut disks or rout circular grooves with a drill press or an electric hand drill, using either a routing bit or an end mill as the cutter. On the drill press, the work is rotated; with the hand drill, the cutter moves, the work being firmly fastened to the workbench. Collars can be used to regulate routing depth.

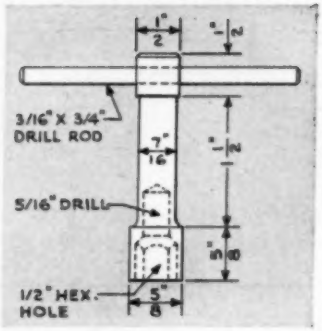
After a ⅜" hole has been made in the 1" bushing case, drill a ¼" hole for the 5½" long arm and tap the hole for threads cut on the arm. Then press-fit the hardened bushing by pushing it home in a vise as seen below. Drill a ¼" center hole in the slide—a ¼" section of ⅜" drill rod—and drill and tap a ⅛"-diameter hole for the 1" pivot. Tap this hole only part way so the pivot will not bear on the arm. On the opposite side, drill and tap a hole for the setscrew. Lubricate the inside of the bushing so friction will not bind the cutter or burn it.







From a screw like this a wrench can be made for use, as at top, on model-engine spark plugs.



Miniature SOCKET WRENCHES

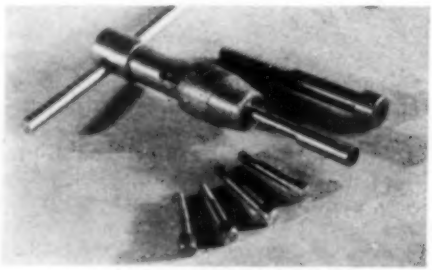
MODELMAKERS who need small socket wrenches for assembling their projects might try using standard hollow-head screws. These screws are usually of good steel and fairly hard, but not so hard that they can't be turned in the lathe without annealing.

The large screw shown above has a hexagon hole ½" across flats and makes up to fit model-engine spark plugs of the V-plug size. Wrenches can be made the same way for ⅜" V-2 and 5/16" V-3 spark plugs.

Chuck the head of the screw true so the outboard end will show no wobble, drill a center hole, and support the drilled end with the tailstock center. Then turn down the threads and turn the shank to the shape shown in the drawing. Reverse the work, turn the head to size, and drill a 5/16" clearance hole for the top of the spark plug to a depth not less than 1" from the outer edge of the head. Cross-drill the opposite end next and drive in tightly a short length of 3/16" drill rod for a handle.

Still smaller socket wrenches for model-size cap screws can be made similarly, but with the shank turned the same diameter from head to end. They may then be used in a tap wrench, thus requiring no handle.

Threads on very small hollow-head screws are best left on and screwed into a short length of steel rod tapped to fit. A crossbar handle can be added. In this way even the smallest hollow-head setscrews can be made up into socket wrenches for tiny hexagon-head screws.



Socket wrenches for model cap screws can be made up with straight shanks and used in a tap wrench.

Here is how the model spark-plug wrench is made. The shank is turned to shape; then the work . . .

. . . is reversed in the chuck and the head shaped. Finally, it is cross-drilled to receive the handle.

Paste flux from the kit is applied to the spliced wires, and soldering tape is twisted tightly around the splice.

Unused tape is then put safely away—it is highly inflammable—and the twist is fired.

Flame and sparks follow the twist along the splice. Take precautions to protect clothing and woodwork from damage.

The surplus of melted solder is wiped off, and the soldered connection is left clean.

Self-Heating Solder Does Job Without Use of Iron or Torch

MANY soldering jobs can be simplified by the use of a new soldering tape that carries its own heat and is ignited with a match or cigarette lighter. The tape is made up of solder on one side and plastic containing a chemical fuel on the other. Twisted solder-side down on spliced wires, or laid over a hole to be plugged or between two metal surfaces to be joined, the solder can be flowed onto the work in less time than it takes to heat a torch or soldering iron.

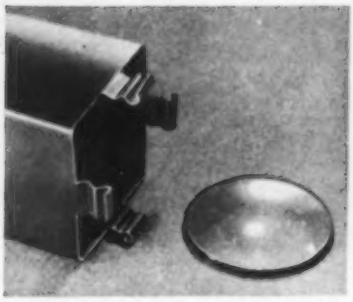
Paste flux to be used with the self-soldering tape comes in the kit. The tape can be used like any ordinary solder on tin, copper, and brass. Surfaces to be joined have to be scraped clean, as usual, in order to make the solder stick.

The product is made by W. B. Franklin Company, of San Fernando, Calif., in 75-cent and $1.50 kits.

Powder Starts Arc for Welding

AN ARC-WELDING starter that eliminates contact between the electrode and the work and prevents blown fuses caused by the electrode freezing to the work is offered by the Electrical Engineering Company, of Indianapolis, for both A.C. and D.C. welding.

Illustrated is a test with a pinch of starting powder on a ¼" square of .020" cold-rolled steel unclamped on the work table. At 15-amp. welding heat, the arc starts before the electrode touches the work.



Tabs ⅜" wide and ⅞" long are left on one end and shaped into clips to hold the lens in place. To protect the lens, bind a narrow strip of tape around its edge.

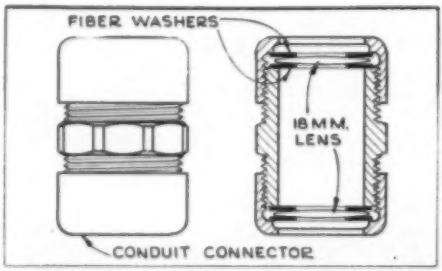
On the opposite end, tabs are bent outward in a U-shape on three of the edges to receive the 2" by 2" slides.

To use the viewer at a desk or table, direct a light toward a sheet of white paper at close range and view slides against the paper.

Simple Slide Viewer Shaped from Tin

METAL cut from a large tin can will provide the material for the body of this convenient slide viewer. The only soldering required is where the edges are fitted together into a seam at one corner.

Before cutting the metal, determine the working distance of the lens by experiment, for this will determine the length of the viewer. The model shown is 3½" long and 1 13/16" square. At one end, tabs on three edges are bent into a U-shape to receive the slides, and at the other tabs on all four edges are formed into clips to hold the lens. The viewer will be more efficient if the inside is coated with dull black photographic paint. In use the device is of course directed toward a window or other light source.—ROBERT SCOTT.

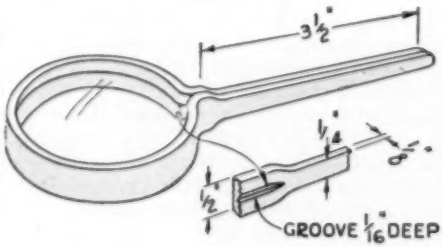


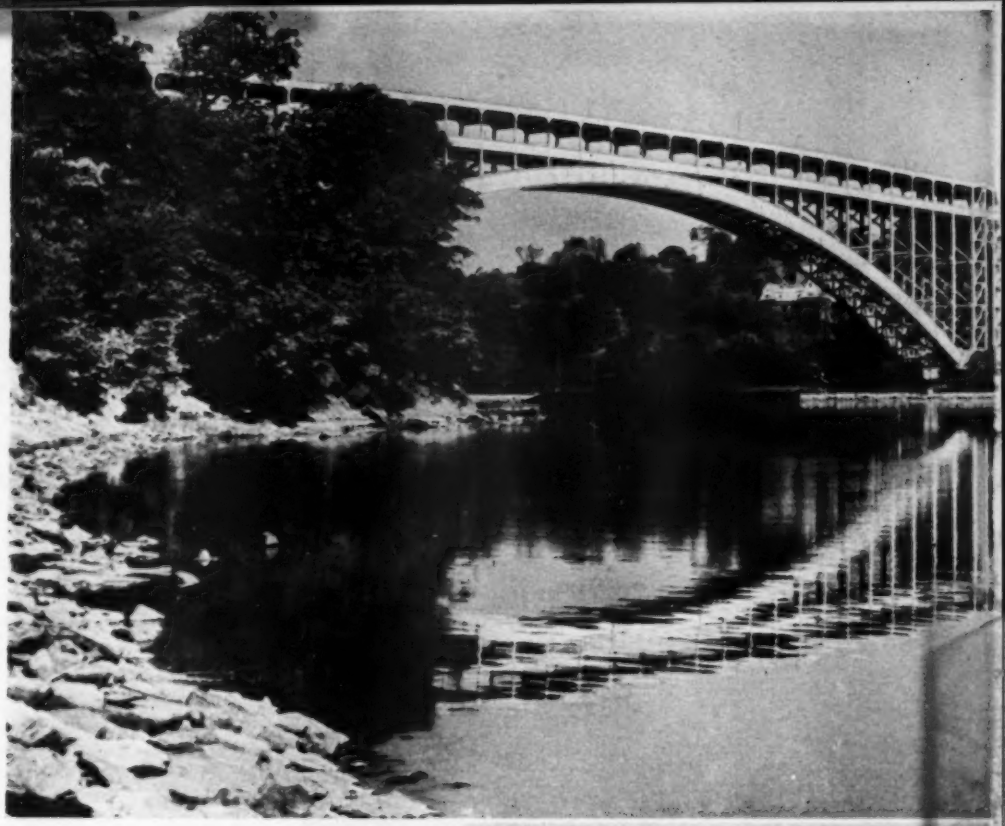
Conduit Fitting Holds Lenses

Two 18-mm. lenses, each having a focal length of 50 mm., can be mounted in a standard electrical conduit connector to make a convenient hand magnifier. The conduit connector comes apart in three pieces. In each end piece, sandwich a lens between two fiber washers, ¾" in diameter with a ⅜" hole. Then screw the parts of the connector back together.—ALFRED BLAKER.

Lens Set in Plastic Handle

MOUNTED in this plastic holder, a magnifying lens is less likely to be damaged when you put it down. Cut a groove 1/16" deep equal in length to the circumference of the lens, using a V-shaped chisel or a routing tool. Smooth and round off the edges with sandpaper, heat the plastic in an oven until soft, remove with gloved hands, and bend around a suitable form. Insert the lens and cement the handle.—FRANK SHORE.





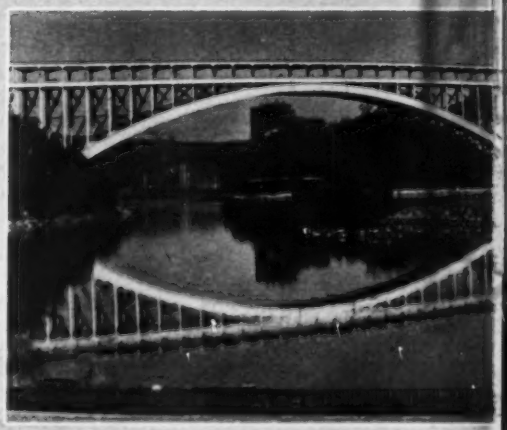
Shoot LESS Show MORE

By FRITZ W. NEUGASS

THERE is a Latin proverb, "*De gustibus non est disputandum,*" that means, "You can't argue about taste"—but the Romans didn't know anything about cameras. We photographers can't help arguing about taste, and we even get something out of it.

Recently I went with my Rolleiflex, my tripod, and my friend Dick to a meeting place of photo fans—the catacombs under the highway along the Hudson River at 79th Street. The view hunters find ample opportunity there to shoot the river and the Jersey shore through arches and vaults. Now

Actually less space is encompassed by the camera in the photo above than in that below, but which picture would you say shows more? By taking his stand closer to the bridge, the photographer has achieved a sense of distance that the foreground expanse of river in the lower photo dwarfs, and he has captured detail even on the distant shore.



Snapped head-on under an arch, the photo above includes so much that no basic theme stands out. Pictorially it's dull because of parallel lines and symmetry. The view below sacrifices details for dominating architectural lines and diagonals that accentuate depth.

Dick is a fellow who is usually pretty sure that he's right. This time I gave in and followed his suggestions.

Dick liked the wide arch spanning almost a half circle; he liked the people sitting and standing in the foreground; he liked the flag in the center; and, recently discharged from the Navy, he didn't want to miss the warship at anchor.

My conception, however, was quite different. The symmetry in his composition, the heavy vault, and the many parallel horizontal lines impressed me less than the picture that was waiting only a few feet away, at an angle that transformed the arch into almost a Gothic point. I discarded the foreground figures, concentrating upon the massively constructed arch and upon the strong diagonal patterns. Later, in the darkroom, Dick found my conception of the scene empty and unappealing, just as I had found his conception cluttered and a little obvious.

The sight of downtown New York thrilled Dick. He saw the skyscrapers stretching toward the sky; he was enchanted by the elevated and by the traffic on the street. His only regret when I snapped the lower picture on the facing page was that no train was passing by.

But only a few steps forward, I discovered a new approach to this same photographic subject. Attempting to bring some order into this pell-mell scene, I concentrated my composition within the heavy frame of the elevated with its curved shape and strong black tone. Dick agreed that the picture had something, but

Two ways of looking at New York. At right, the confusion of street, elevated, and sky-scrapers is true to life, but hardly a picture. Above, the distracting multitude of motifs is suppressed in favor of one — the cluster of buildings framed by the "El".

he couldn't forgive me for cutting out the people and cars.

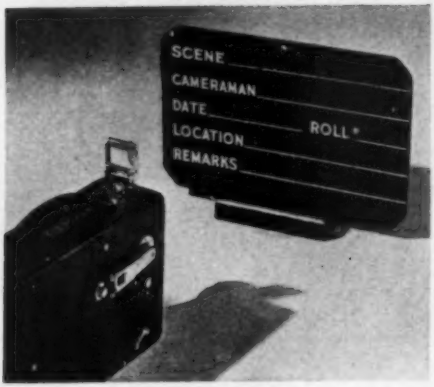
Again, along a stream, Dick picked a spot that would show almost the entire arch of a graceful bridge and its full reflection in the clear water. We walked a little distance along the bank, and I stopped at a point where we could look up at the bridge to make it appear higher, where we could find detail in the rocks and foliage of the near shore and not be so far away that contrast would be lost in the background.

The result pleased even Dick. He was willing at last to admit that often the camera can capture more while aiming at less, that the whole may be clearer through detail of a part. END

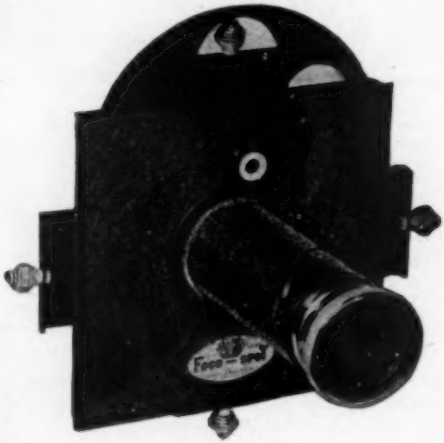
PHOTO IDEAS and EQUIPMENT

PROCESSING MOVIE FILM. Amateurs who shoot their own movie titles on positive stock can develop lengths up to 36″ on cut-film hangers. Tape one end of the film to the upper corner of the hanger, wind the film around the frame as shown, and tape the other end also.—LOUIS HOCHMAN.

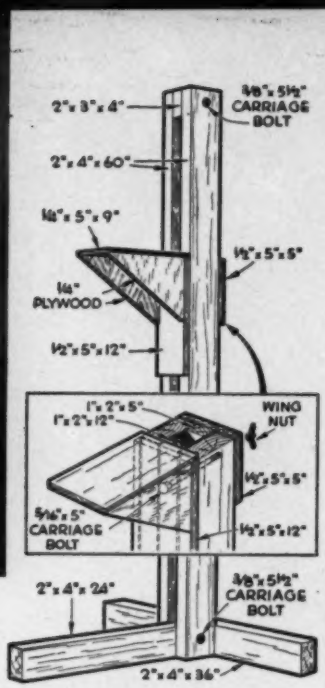
BRUSH USEFUL IN DARKROOM. Shoe-polish applicators of the type shown below have many uses in a darkroom. Their soft sponge daubers won't hurt prints or negatives. Here, one is being used to apply Farmer's reducer.—H. LEEPER.



SLATE IDENTIFIES MOVIES. For amateur movie makers, the Cine-Slate above offers a means of identifying each roll, scene, date, cameraman, and location in the same way that is used in Hollywood. Marketed by the Sherwood Products Company, of Forest Hills, N. Y., it measures only 6″ by 9″, making it convenient to carry.



FOCO-SPOT CONTROLS LIGHT. Designed for use with the Bardwell & McAlister Baby Keg-Lite, the new B & M Foco-Spot shown above enables a photographer to confine light to any given area or shape of spot and to vary the focus and intensity at will. Four mats for rectangular effects and a revolving disk with apertures of various sizes offer a wide choice of light shapes. In addition, designs may be painted on glass slides and projected on a background, while the lenses mounted in the tube give easy focusing.



Despite its cumbersome appearance, this studio stand is readily maneuverable. One wing nut loosens the camera shelf for quick adjustment to any level. The base slides on dome gliders.

STUDIO STAND ADJUSTS EASILY. In a home studio, a camera stand such as this is more convenient than the ordinary tripod. It is set more quickly to different levels and is less likely to be upset.

Although supporting members of this particular stand are cut from two-by-fours, you can use lumber of smaller size if you wish—and still retain rigidity. In addition to two ⅜" by 5½" carriage bolts, 20d. nails are used to hold together the five pieces of the base and standard so as to assure rigidity.

Brad and glue together the plywood parts of the camera shelf, and attach the ½" by 5" by 12" facing member to the 1" by 2" by 12" inside slide in the same way. The ½" by 5" by 5" piece at the back also is bradded and glued to its sliding guide. These front and back clamping members separate when the wing nut is loosened. Give all sliding faces a thin coat of melted paraffin for easy action.—CHARLES KIMBALL.

FAIRYTALE STUDIO. As every photographer knows, it often is difficult to get a good expression and pose when taking a portrait of a child. In his studio at Bronxville, N. Y., Pat Candido has eliminated this difficulty. While the youngsters watch a movie, a remote-controlled camera, aimed at them through an opening beneath the small screen, catches their changing expressions. Disguised as sunflowers, high-speed electric repeater flash lamps operate almost unnoticed by the children. The studio is decorated with fairytale murals.

Elusive short-wave signals often come in best at night, so headphones are built into this two-band superheterodyne for midnight DX listening. Flicking a couple of switches, however, brings in the full broadcast band at loudspeaker volume.

By FRANK TOBIN

THREE tubes for a two-band superhet doesn't suggest much power, but there's plenty of pickup and drive in this circuit to pull in the 20 and 40-meter ham-band transmitters as well as short-wave broadcasts from Europe and Australia. Reception on the broadcast band is clear and loud; a 10-foot hank of antenna wire strung out along the floor will usually be sufficient to get local stations at full loudspeaker volume, and an external ground can be omitted altogether. For remote locations or good DX listening, of course, you'll want a more substantial antenna and a good ground.

Being battery operated, this set is ideal for camp, hunting lodge, or week-end cabin as well as for the den. The use of only three tubes allows economical operation on dry batteries.

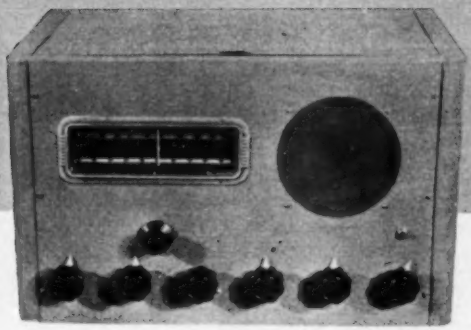
Considerations of size played practically no part in the selection of the midget 3S4 power tube; what is important about the tube is that it will maintain good and undistorted output at plate potentials down to 65 volts. Most battery-operated power pentodes work well enough with a fresh battery supply, but when the cells age and voltage starts to drop, considerable distortion occurs at normal output levels. The 3S4, however, is built to work in personal radios that normally use 67½-volt batteries, and is therefore capable of distortion-free performance from 90 volts down to 65.

But even this allowance for a sliding plate voltage would do little good if the grid bias were fixed. To insure smooth operation throughout the entire effective life of the battery, a voltage is applied to the control grid of the pentode through an automatic bias circuit as described below, thus keeping the grid and plate voltages in operating harmony.

Within the limits of the circuit's sensitivity, the automatic volume control regulates volume at both the converter and I.F. stages. Fading on distant stations is dimin-

Two-Band SUPERHET

THREE-TUBE CIRCUIT PERMITS COMMUNICATIONS RECEIVER TO OPERATE UP TO 1,000 HOURS ON BATTERY PACK



ished by A.V.C., which also prevents blasting when the set is tuned through the frequencies of local or strong transmitters. Automatic control of volume is obtained by impressing on the grids of the 1A7 and the pentode section of the 3A8 a bias voltage that varies with the strength of the incoming signal. A strong signal increases the bias voltage, thereby reducing the sensitivity of the tubes and decreasing their amplification; a weak signal reverses the process. Bias voltage is fed back from the diode detector section of the 3A8 through a resistance-condenser network.

For night-time listening or when signals are weak, a headphone jack has been included. By taking the phone-jack connections from the voice-coil winding of the output transformer, the phones can be switched in at any time, regardless of volume, without danger of blasting or overloading. Use the transformer tap that gives the most comfortable volume, and be sure that the grounded side of the phones corresponds to the grounded side of the speaker. This connection is shockproof since none of the high voltage flows through the phone circuit.

A variable tone control, consisting of a .1-mfd. tubular condenser (C12) in series with R10, a 75,000-ohm potentiometer, operates on both speaker and phones. By reducing the audibility of higher sound frequencies, this control serves to relieve heavy static conditions. High-pitched code signals can also be changed to more pleasing notes by means of the tone control, and musical programs can be tuned to suit the ear.

When a signal is picked up by the antenna, it is fed into the fourth grid of the 1A7 converter, where it is mixed with a signal generated by the local oscillator to create an intermediate frequency of 456 kc. After passing through the I.F. amplifier, this signal is rectified by the diode detector, then further amplified by the first audio tube. All three functions—I.F. amplifier, diode detector, and first audio—are performed by the single 3A8 tube. Building a pentode amplifier, diode rectifier, and high-mu triode into one glass envelope not only saves space, parts and work for the builder, but also cuts down filament current drain.

The output of the 3A8 amplifier triode is resistance coupled to the control grid of the 3S4 power pentode through a 75,000-ohm plate resistor, a .05-mfd. coupling condenser, and a 1-meg. grid resistor. A mica condenser of 100-mmf. capacity in the plate circuit of the first audio stage by-passes any unrectified R.F. current to ground, preventing it from weakening or distorting the desired signal.

Through an output transformer, the audio-frequency currents flowing in the plate circuit of the 3S4 are fed into a 6" P.M. speaker. Load resistance of the tube is about 5,000 ohms; a selection of taps on the secondary of the transformer permits matching of this resistance to the speaker's voice-coil impedance.

Grid bias for the 3S4 is obtained by means of a 600-ohm resistor, R9, in series with the negative 90-volt lead and ground. The voltage drop across this resistor is impressed on the grid of the tube through the 1-meg. grid leak, R8. As the B voltage drops, so does the negative bias on the tube, resulting in a compensating increase in amplification. Automatically regulated bias permits the power tube to function efficiently even though the output voltage of the B battery

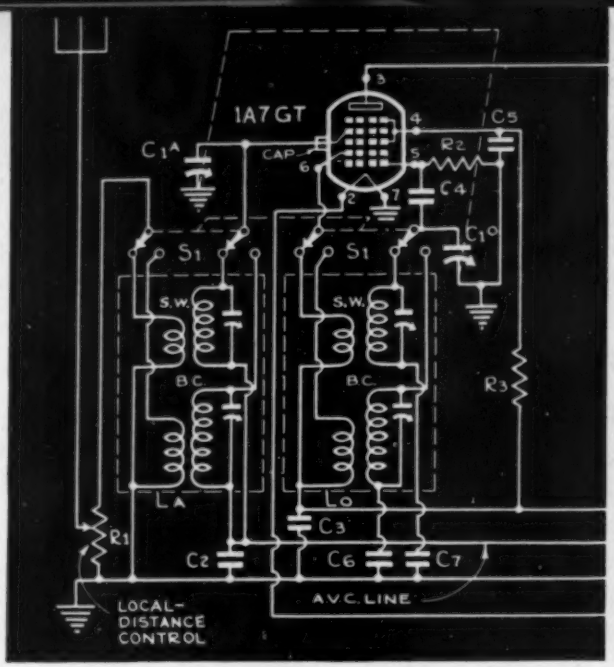
falls by as much as a third.

To protect the loudspeaker cone from damage, a wire screen is placed over the speaker frame. The screen is covered by a grille cloth before the speaker is bolted to the front panel.

The number of knobs in use could have been reduced if space had demanded, but it will probably prove convenient to have the full number. From left to right, these knobs control: sensitivity (R1, for local-distance tuning), wave band (S1), volume (R6), tone (R10), power (S3, on-off switch), and speaker or headphone output (S2).

Although the volume control and power switch might easily have been combined, the latter is also useful as a quick-action stand-by switch because the battery circuit requires practically no warm-up time. When the set is played through the loudspeaker, the speaker-headphone switch will provide even more instantaneous stand-by control.

Three-scale slide-rule dials of the type shown may be obtained with all the necessary calibrations for both broadcast and short-wave bands, plus a 0-100 scale for logging purposes.



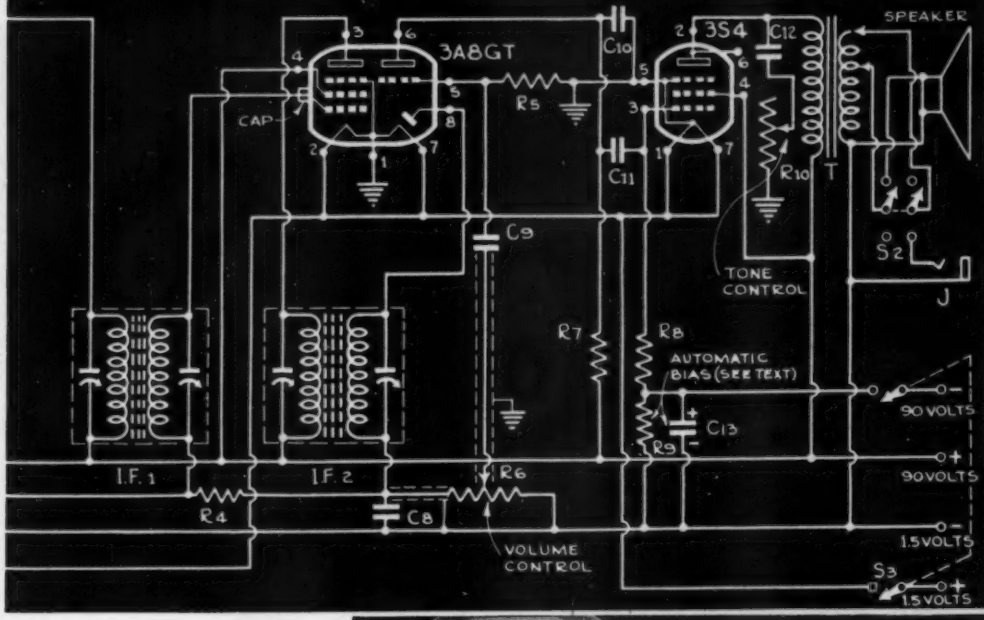
LIST OF PARTS

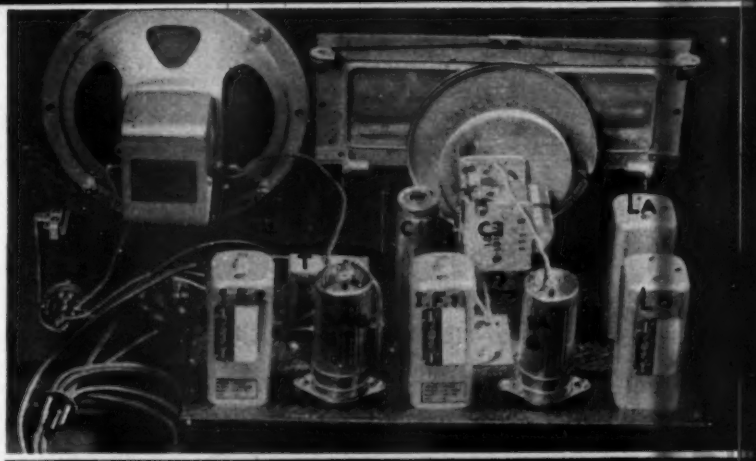
C1: 360-mmf. two-gang tuning condenser.
C2, C3, C5, C12: .1-mfd., 600-volt paper tubular.
C4: 250-mmf. mica.
C6: 400-mmf. mica, close tolerance.
C7: .01-mfd. mica, close tolerance.
C8, C10: 100-mmf. mica.
C9, C11: .05-mfd., 600-volt paper tubular.
C13: 16 mfd., 200-volt electrolytic.
R1: 250,000-ohm potentiometer.
R2: 50,000-ohm, ½-watt carbon.
R3: 10,000-ohm, 1-watt carbon.
R4, R5: 2-meg., 1-watt carbon.
R6: 1-meg. pot.
R7: 75,000-ohm, ½-watt carbon.
R8: 1-meg., 1-watt carbon.
R9: 600-ohm, 1-watt carbon.
R10: 75,000-ohm pot.
S1: 4-pole D.T. rotary band switch.
S2: D.P.D.T. rotary.
S3: D.P.S.T. rotary.
LA: Shielded antenna coil, 540-1,500 kc., and 5,500-18,000 kc.
LO: Shielded oscillator coil, same bands.
I.F.1: Iron-core I.F. input transformer, 456 kc.
I.F.2: Iron-core I.F. output transformer, 456 kc.
T: Universal output transformer.
J: Headphone jack and plug.
Tubes, chassis, cabinet, 6" P.M. speaker, sockets, knobs, hardware, etc.

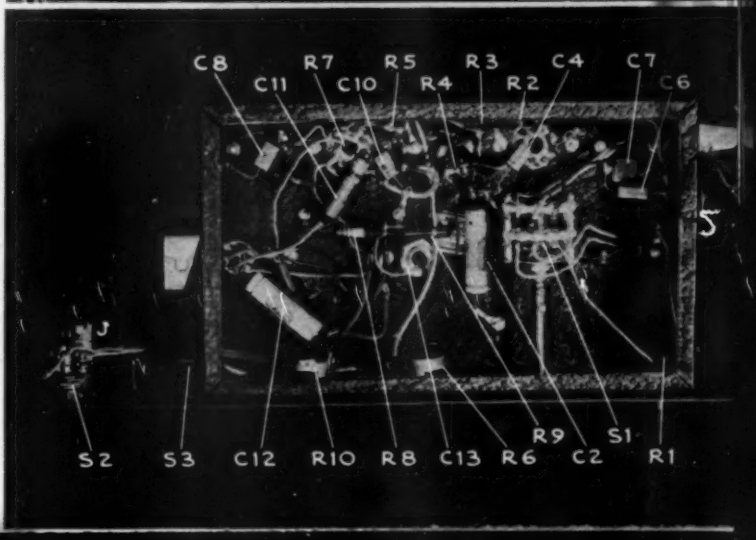
To align the set a modulated signal generator is, of course, desirable. If one is available, ground the shielded cable to the chassis and clip the live conductor to the grid of the 3A8 pentode. Tune the generator to 456 kc. and adjust the secondary and then the primary of I.F.2 for maximum sound at the speaker. Work backward through the first I.F. transformer. Tune the R.F. stage by removing the screws on the condenser (CI) trimmer and aligning the trimmers first on the oscillator and then on the antenna coils. Broadcast and short-wave bands will have to be tuned separately. Use a 1,500-kc. R.F. signal for the former and 15 or 16 mc. for the latter.

If you don't have a signal generator, you can tune by ear by first getting the strongest station you can find, and working backward in the sequence described above until the signal comes through with the greatest volume. It may be necessary to do the aligning of the short-wave band at night when strong stations are easier to find. Most I.F. transformers are factory tuned with sufficient precision to allow a strong signal to get through.

Cabinet size will depend largely on your individual requirements. The one shown was

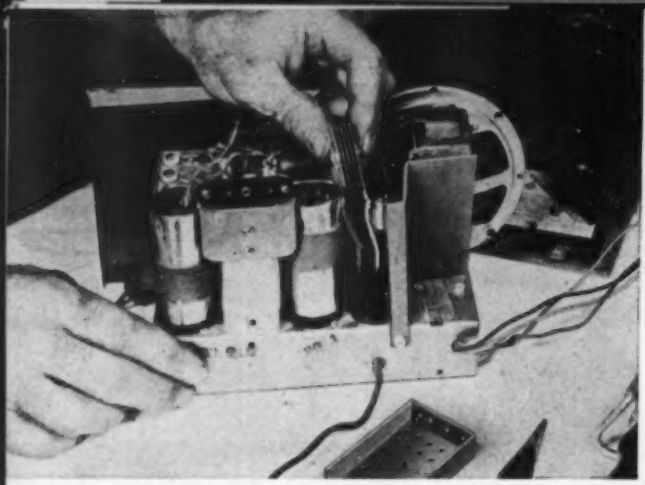






selected because it has room for a 1,000-hour power supply. Battery packs that deliver 1.5 volts for the filaments and 90 volts for the plates are now available in a variety of sizes and shapes. Where portability is a factor, a small pack may be used, in which case the cabinet can be much reduced in size. The larger of the so-called "farm" packs are estimated to be good for a full year of service with this low-drain circuit, based on average daily use of about three hours.

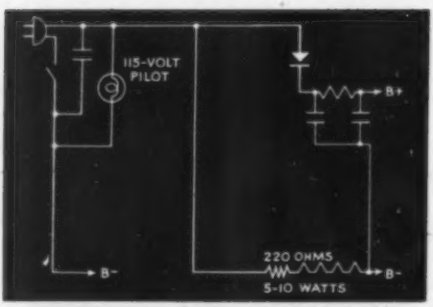
For extra usefulness the set may be readily converted to 115-volt A.C. or D.C. operation. A forthcoming article will describe a suitable dry-disk rectifier unit that will enable the builder to install a complete three-way power supply. END

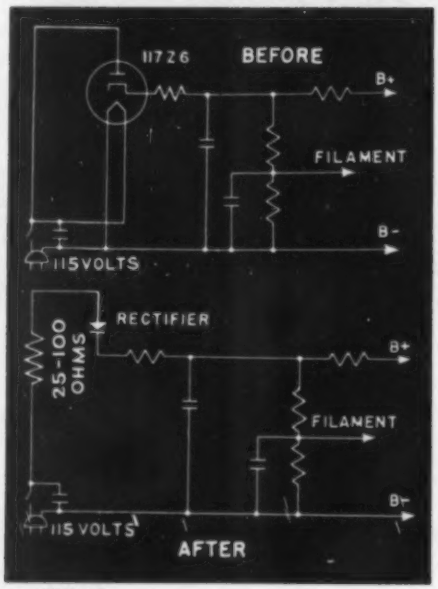


If the rectifier stack doesn't fit conveniently beneath the chassis, solder two extension leads to its terminals and install the disk over the empty tube socket.

Dry-Disk RECTIFIER

REPLACES BURNED-OUT TUBES

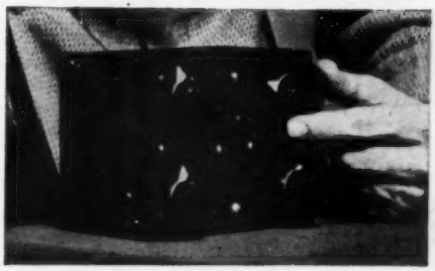




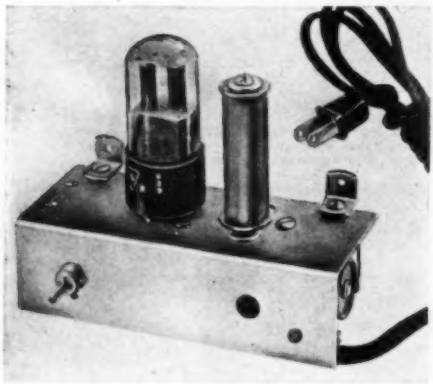
PRACTICALLY all commonly used rectifier tubes are now replaceable by dry-disk selenium rectifiers. They not only take the place of hard-to-get tubes, but are also smaller, cooler and quicker in operation (because they have no filaments to warm up), and they won't burn out or break under conditions that generally damage tubes.

Details of the replacement vary from set to set; the diagrams on this page show two typical installations. One involves a 35Z5 tube and the other a 117Z6. In the former case tube filaments are in series, requiring a 200-ohm, 5- to 10-watt resistor to be inserted in the line to provide continuity for the other heaters. Since the pilot light is generally operated off the center tap of the 35Z5, some changes are called for in that circuit as well. One of the simpler solutions to the pilot-light problem is shown at the upper left. The original pilot connections are shunted, and a 115-volt bulb is connected between the cold side of the power switch and the old tube's plate prong.

Where a tube of the 117-volt type is being replaced, a series resistor of between 25 and 100 ohms is needed (as shown in the bottom drawing) to compensate for the lower internal resistance of the dry disk. The filament connections, however, may be removed without affecting the other tubes.



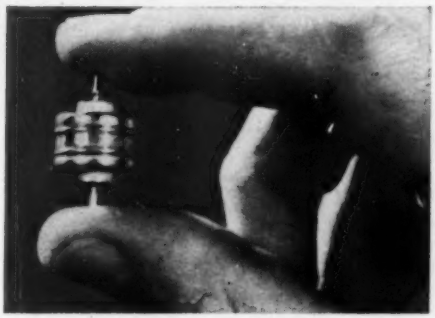
DX BOOSTER. For hams who have trouble picking weak signals out of the crowded, noisy airways, General Electric has designed the broad-band preamplifier and impedance-matching unit shown above. The combination of matching antenna to receiver and adding an extra RF stage is said to increase gain up to 60 db. The device, known as the "R-9'er" will be made by the James Millen Mfg. Co., of Malden, Mass.



PHONO OSCILLATOR. Exceptional signal strength is claimed for this permeability-tuned oscillator that will play any phonograph through any radio. It is made by the D & M Mfg. Co., of Midland Park, N. J., and is tunable from 550 to 1,500 kc.

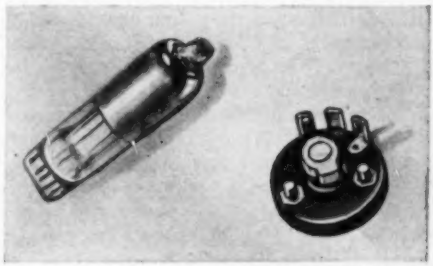
EXTENDING LINE-OF-SIGHT. In a recent test jointly arranged by the American Radio Relay League and the Radio Society of Great Britain, a 50-mc. broadcast from West Hartford, Conn., was received by two British amateurs. Highest frequency ever to be beamed across the ocean, the experiment was a step in extending the reliable service area of high-frequency transmitters, now thought to be limited to about 100 miles.

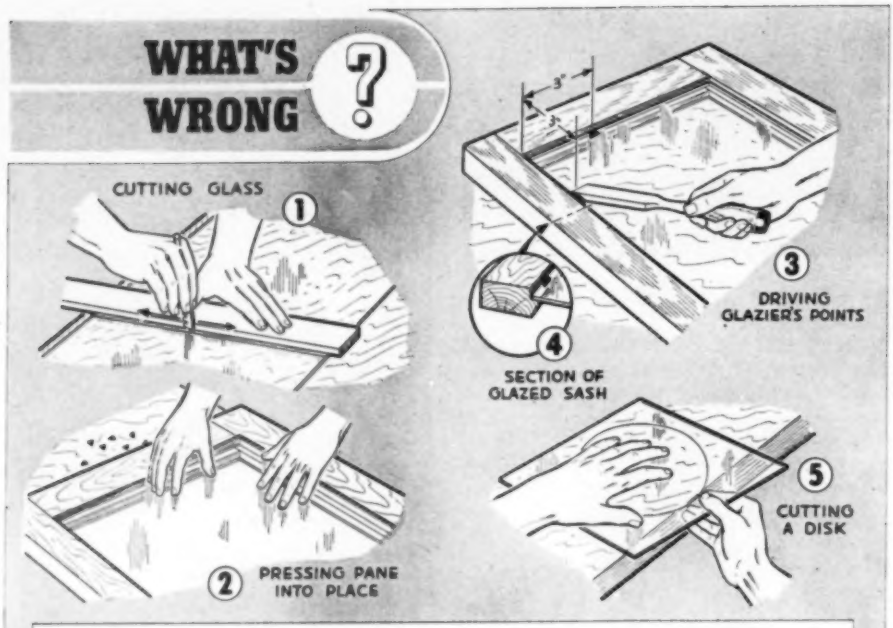
NEWS IN ELECTRONICS



CRYSTAL CONTROL AT 50 MC. A new unit developed by Western Electric provides direct crystal control from 15 to 50 mc., thereby eliminating the need for multiplier stages used in most previous VHF equipment. The development will permit high-frequency transmitters to be made smaller and lighter, and employ fewer components. By reducing the number of undesirable frequency responses present, it will also allow greater scope in the choice of intermediate frequencies and increase the efficiency of new equipment.

TOM THUMB'S THUMB. To meet the need for quality volume controls for midget hearing aids and receivers, Centralab has announced a complete new line of dime-size potentiometers said to be the smallest practical for low-noise, long-life operation. The tiny controls will be available in sizes ranging from 500 ohms to 5 meg. Dust shielding and a selection of mounting positions are also provided.





MISTAKES in glazing usually carry a cash penalty. Can you find the five errors shown here?

ANSWERS

1. Never run the cutter twice over the same line. This dulls and eventually ruins the wheel. A single pass with firm, even pressure is required.

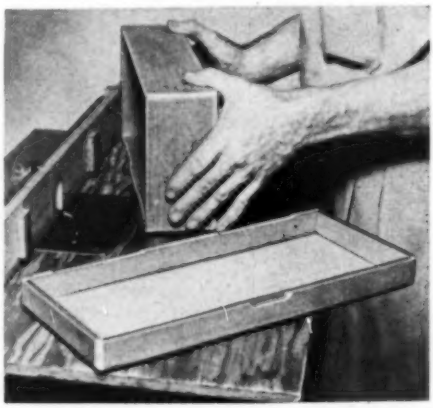
2. The pane should be a close fit, but not so close it has to be forced into the rabbet. Cut the glass ⅛" short each way, allowing a clearance of 1/16" all around.

3. Points should be unequal distances from the corners, say one at 3" and the other at 7". Equal distances create a diagonal strain that may crack the glass.

4. In the best work, and in old work especially, the glass should be bedded in a thin layer of putty spread in the rabbet.

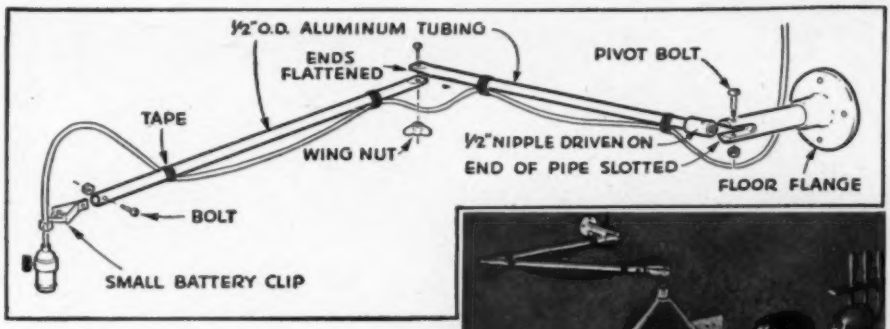
5. Score radial lines outward from the scored circle. It will then be easy to break out a small section at a time.

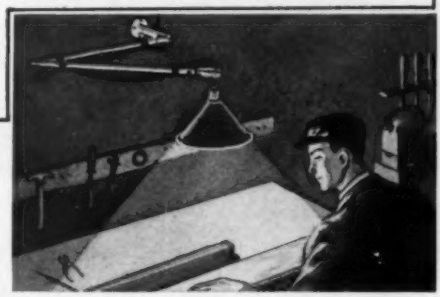
Jig for Forming Hinge Gains Speeds Box Production



WHEN a jointer or small shaper is available, an auxiliary fence with four stops spaced to limit cutting simplifies quantity production of identical hinge-knuckle gains. The stops are so placed that the cuts will be at equal distances from both ends.

A straight cutter is used, being adjusted to project half the thickness of the hinge knuckle beyond the outer face of the fence. If only one section of the box is to carry the "pocket," the cutter is set for full hinge depth. About 100 boxes an hour can be handled.—JOHN P. ARNOLD.



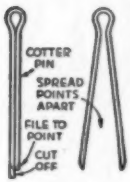


Fully Adjustable Bench Light Will Cover Wide Range

As my workbench is a long one, I needed a good light that would really get around. This one does. The wall mounting is a ¾" floor flange with a 7" length of ¾" pipe slotted to fit a ½" nipple snugly. Lengths of ½" o.d. aluminum tubing, 30" long for the rear, 21" long for the front, form the arms. The inner one is reinforced with a short ½" pipe nipple on one end to pivot in the slot. Its other end is hammered flat and bolted to a flat end of the second tube.

A hole crosswise near the other end of this piece takes a bolt to hold a small battery clip. The lamp cord runs through the clip jaws (behind the teeth, not across them); there's friction enough to hold the socket at any height. Then the cord is taped to the tubing with loops to leave slack at joints. Two loose turns near the socket permit height adjustment.—Herbert Spohn.

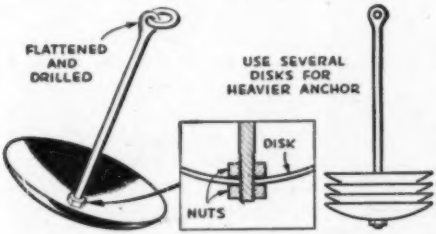
Tweezers Made from Cotter Pin



Miniature tweezers for handling small objects can be improvised from a cotter pin. Cut the legs even and spread them so they'll grasp the work. They have just enough natural spring.

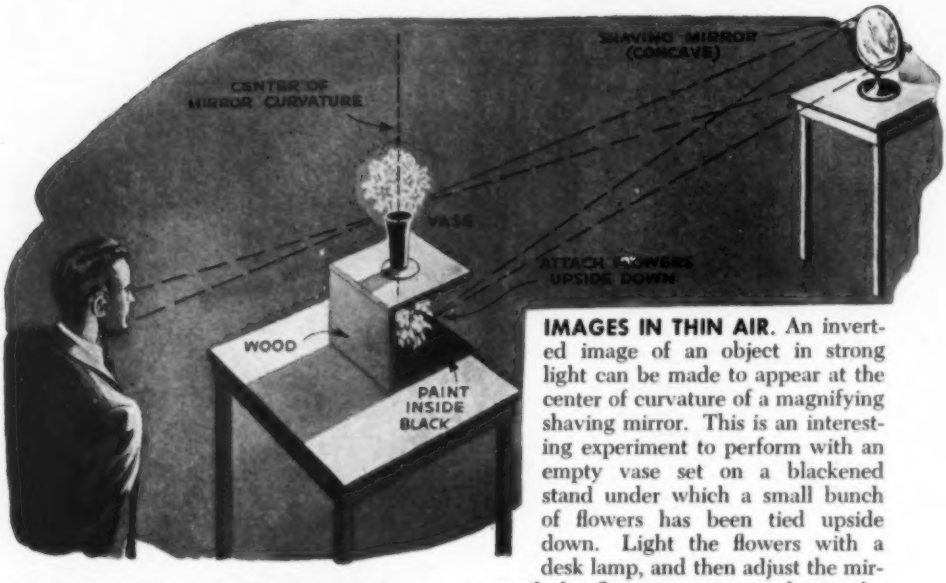
Cultivator Disks Form Anchor

A light mushroom anchor can be made by bolting a cultivator disk to a length of rod and fitting a shackle to the other end. Use several disks for a heavy anchor.



Template for Mounting Stamps

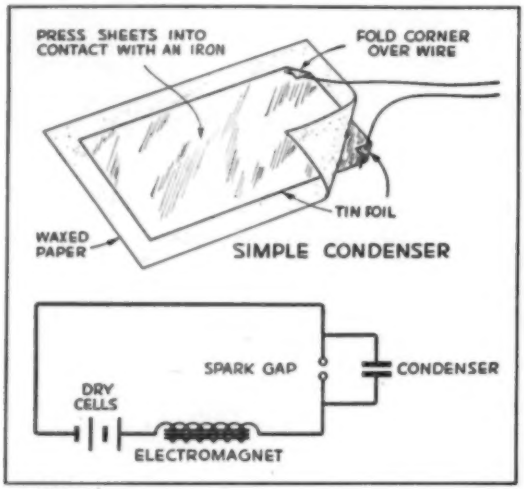
When extra sheets have to be added to a stamp album, they are usually in blank form except for border lines. A template cut from stiff cardboard or thin plastic will help get even spacing. The sheet should be the same size as the album page. Rule and cut with a sharp knife along a straightedge two or three rows of rectangles for average-size stamps and a row or two additional for oversize ones.—E. A. Rerucha.



IMAGES IN THIN AIR. An inverted image of an object in strong light can be made to appear at the center of curvature of a magnifying shaving mirror. This is an interesting experiment to perform with an empty vase set on a blackened stand under which a small bunch of flowers has been tied upside down. Light the flowers with a desk lamp, and then adjust the mirror until the flowers appear to be in the vase. The point where the image appears natural size is the center of curvature of the mirror and of an imaginary sphere of which the mirror can be considered a small surface area.

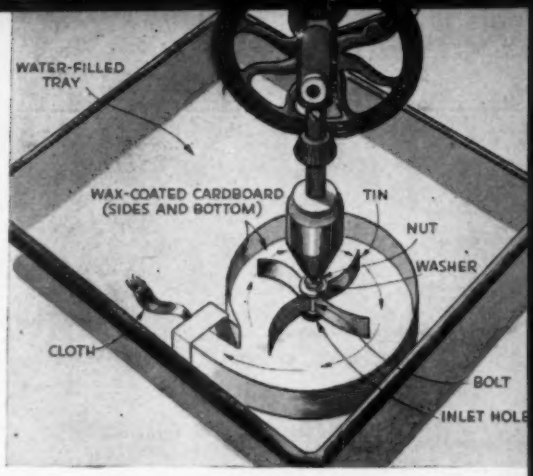
HOME EXPERIMENTS

Odd Facts About PHYSICS



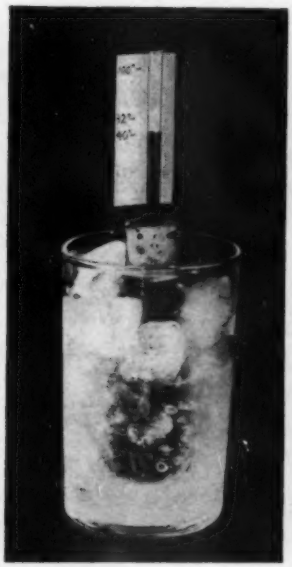
WHY CARS NEED CONDENSERS. If you connect an electromagnet in series with several dry cells and break the circuit, a hot spark will jump the break because of extra voltage produced by the collapse of the magnetic field about the magnet. But connect in the circuit a radio filter condenser, an automobile condenser, or even one made by sandwiching a sheet of waxed paper between two pieces of tin foil, again break the circuit, and you will find the spark greatly diminished. On a car timer, this diminishing of the spark not only makes the contact points last longer, but it also causes a stronger and more accurately timed spark at the plugs where it is needed.

ACTION OF CENTRIFUGAL PUMP. With a volute casing made from waxed cardboard and an impeller wheel bent from tin, the discharge action of a centrifugal pump can be shown. Bend two strips of tin at right angles and curve each half in the same direction. Clamp both bent pieces between washers on a bolt by drawing the nut down tight, and chuck in a hand drill. Place the casing in a pan of water, center the bolt head in a hole in the bottom of the casing, and rotate the wheel clockwise. Water will be drawn into the hole and forced out at the end of the spiral. A pennant at the opening will show the movement.



HOT LIQUID FLOATS. That hot water is lighter than cold can be shown by an experiment with hot coffee. Half fill a tumbler with cold water, float a small piece of cardboard on it, and pour in hot coffee slowly through a funnel held close to the cardboard. The two fluids will mix only slowly. Use a thin glass to prevent cracking by temperature change.

WATER EXPANDS AS IT FREEZES. Many householders have had this demonstrated for them by bursting water pipes. You can show this characteristic with a tumbler of ice and a test tube of colored water. Put a thin glass tube through a hole in a cork, press the cork into the test tube until the liquid rises in the tube, and mark the temperature on a paper scale behind the tube. Mark the lowest point on the scale as the water grows cold, which would be about 40 deg. F. if you could take the temperature of the water, and mark the high point as the water again rises. This will be 32 deg. Actual freezing of the water probably will force the cork out.

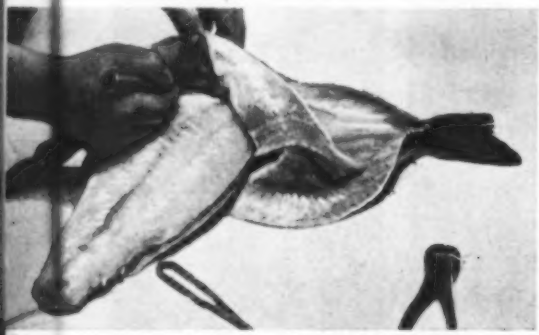


FISH STORY on a Plaque

How to mount the big one that didn't get away. A taxidermist describes a quick home method.

By BERLEN DIEHM

Select the best side to show, turn to the other side, and split from gill to tail. Skin out the meat with a fish skinner or hacksaw blade.



Then cut the body (meat) from the head. It can be consigned to the frying pan. The head is next cleaned thoroughly with a pair of pliers.

Scraping with a hacksaw blade removes all traces of meat from the skin, which is then rinsed with water and submerged in alcohol to tan.

WOULD you like to save that prize catch as proof of your favorite fish story? You can easily mount it on a plaque to confound all doubters. By a new method using a plaster of Paris core, the old tedious carving of a balsa-wood form for the skin is dispensed with entirely, and actual work-time on the job is cut from seven hours to 30 minutes. An extra eight hours must still be allowed for tanning, of course, and another seven to 10 days for the mounted fish to dry, but these are merely waiting periods and involve no work on the part of the taxidermist.

The fish ought to be well cared for immediately after catching, that is, not exposed to the sun. When you get it on the workbench, select the best side to be shown and slit the opposite side for its entire length from gill to tail. Skin out the meat with a fish skinner (knife) or hacksaw blade and cut it from the head; then clean inside the head thoroughly with pliers and scrape inside the body skin with a hacksaw blade until it is perfectly clean.

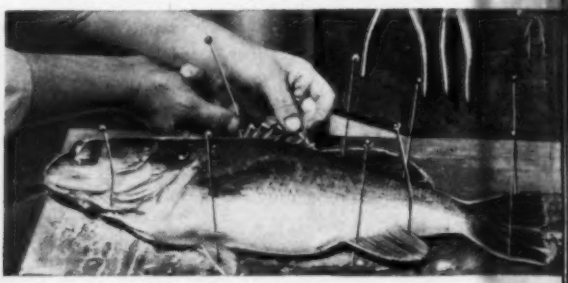
Rinse the skin with water, and then submerge it in alcohol for eight hours to tan it, following with another water rinse when it is removed from the tanning bath. Sew up the cut side and pour the skin full of a mixture of plaster of Paris and zonolite in just enough water for good pouring consistency. If a helper will hold the skin up for you, the plaster mixture can be poured in easily.

Lay the fish on a board and shape it immediately before the plaster can set. Fill the head with the plaster mixture next and shape it properly. The fins are then fastened in position with pins, and the filled fish is left on the board to dry, a matter of seven to 10 days, after which it is affixed to the

Natural coloring is restored to the mounted and dried fish with water colors, and a coat of varnish is then applied to the entire surface. Color restoration is necessary since mounting turns the fish white.

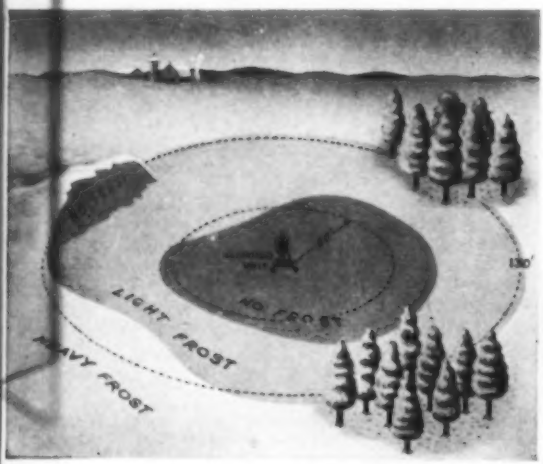
mounting board or plaque with wood screws through the plaque into the plaster core.

Take careful note of the coloring of the fish before mounting, for the plaster mixture will turn the skin white as it dries and the coloring will have to be restored. This can best be done with water colors, which will bring out the natural coloring if properly used. The job is then completed with a coat of varnish over the entire fish and the wood plaque to protect them from dust and to preserve the color.



After tanning, the skin is rinsed again, the cut sewed up, and the cavity filled with a mixture of plaster of Paris and zonolite, a mica insulating material available at building supply dealers. Plaster and zonolite are used in half and half proportions. As soon as filling is completed, the fish is laid on a board and shaped, and the fins are held in position with pins, as above, until it has dried. This takes about a week.

Experimenters at Michigan State College developed this huge oil burner to determine whether radiant heat would protect farm crops from frost damage.



On one night, the experimental oil burner gave the results sketched above. It prevented frost within a radius of 60' to 100', as well as at a distant spot that sloped toward the unit. Although the air temperature was 31 deg. F., the vegetation within the heavily shaded area dropped only to 37 deg.

RADIANT ENERGY Nips Jack Frost

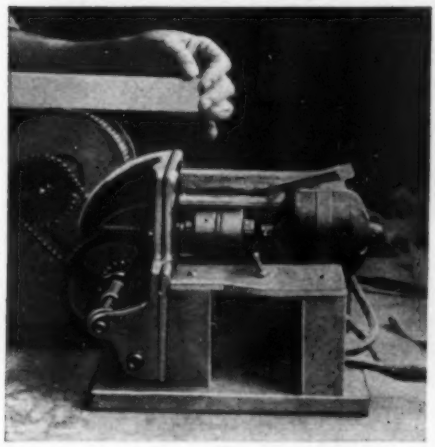
EXPERIMENTS conducted at Michigan State College hold a promise that fruit growers and truck farmers eventually may be able to use radiant heat to prevent frost damage. In the tests, a huge oil burner and an electrical unit both were successfully employed to direct radiant heat on the vegetation and keep it above the frost point without using the air itself as the medium of heat transfer.

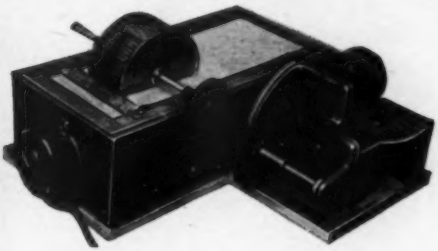
The electrical unit consists of aluminum reflectors with rod-type electric heating elements placed 10′ above the ground and connected to a 440-volt A.C. line, the reflectors being shaped to distribute the infrared radiant energy over an area 40′ square. Even on the coldest night the apparatus was in use, it gave effective frost protection.

Because the cost of electrical energy would make this method impracticable for many growers, the Michigan experimenters also developed and are testing an oil-heated radiation unit. This consists of a large heater tube that operates at low red heat and circular reflectors to direct the heat down against the crop. Kerosene is stored in three 30-gal. hot-water tanks. After further development, it is hoped that a single oil unit will protect an acre of crops.

Infrared radiant energy from this experimental electrical unit also prevented frost from forming.

Motorized Drum Gluing Machine Coats Work Swiftly and Evenly





WHEN Russell Jackson, of Angola, Ind., expanded his home workshop for the production of instrument cases, he built this drum gluing machine to speed the job.

A 5-qt. stainless-steel glue tank is flanged so it can be set into a 6″ by 8″ by 17″ sheet-brass casing with 1¼″ clearance all around. The casing is lined with ¼″ corrugated asbestos paper. Two 500-watt strip heaters connected in series are placed in the bottom. They are thermostatically regulated to maintain an even 160-deg. temperature.

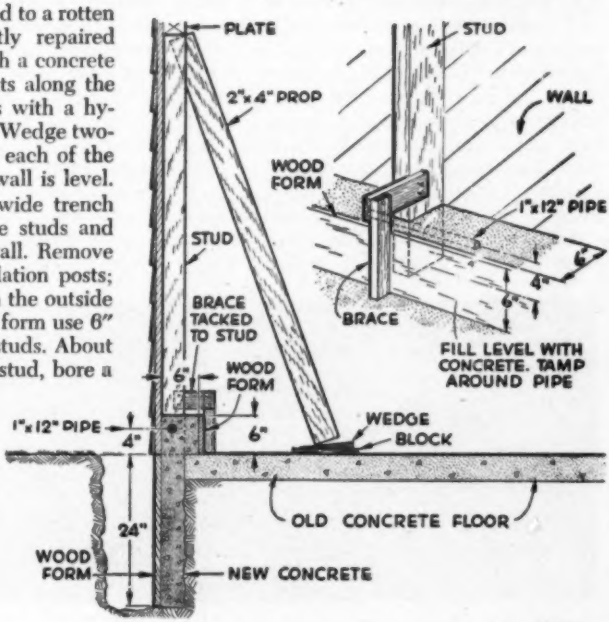
The drum, a 5½″ coffee tin with crimped strips soldered on, is driven at 24 r.p.m. by a fan motor geared through an old phonograph mechanism. An adjustable space bar keeps an even film of glue on the drum. Work is applied in the direction of rotation. Between jobs the heater is disconnected and the glue allowed to harden. It can be brought to working temperature in an hour.

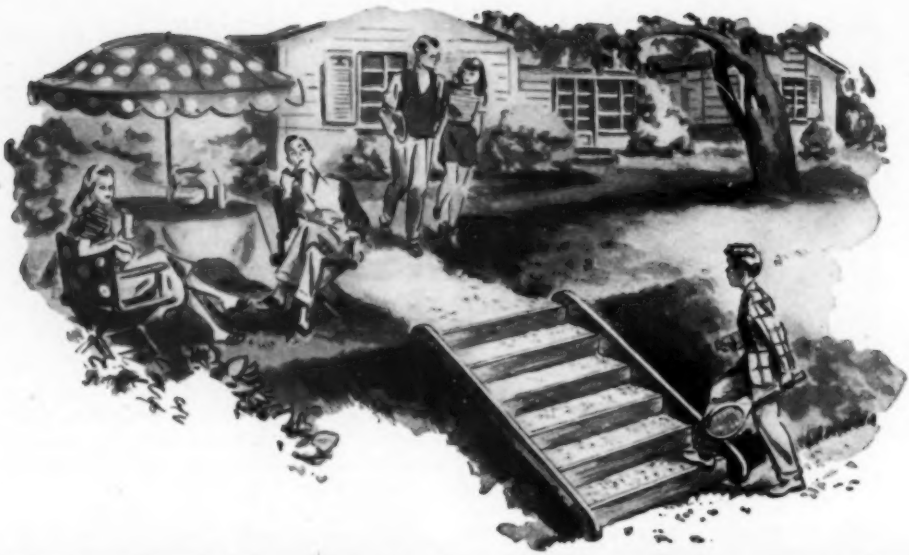
Permanent Concrete Support Takes Sag Out of Old Garage Wall

SAG in a garage wall traced to a rotten mudsill can be permanently repaired by replacing the old sill with a concrete foundation. At several points along the wall, jack the sinking studs with a hydraulic or heavy screw jack. Wedge two-by-fours under the plate at each of the jacked-up points until the wall is level.

Next dig a 2′ deep, 8″ wide trench flush with the inside of the studs and running the length of the wall. Remove the sills and any old foundation posts; then build a form flush with the outside of the studs. For the inside form use 6″ boards braced 2″ from the studs. About 4″ from the bottom of each stud, bore a hole for a short length of reinforcing 1″ pipe.

Pour concrete level with the inside form. Tamp the concrete around the pipe inserts, and when it has set remove the forms and braces from around the work.—ALEXANDER BURK.





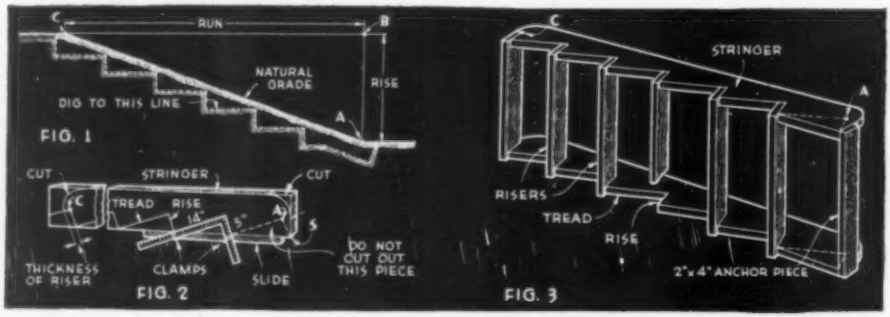
STAIRS for Your Terrace Garden

By H. L. KETCHAM

WHEN an informal garden or a lawn requires terracing, concrete stairs connecting the various levels are frequently too formal to carry out the landscaping scheme. The set of stairs shown here has a charm of unconventionality that is impossible to attain with cement or bricks. Stringers and risers are wood, and the treads are rock dust, also known as quarry waste, laid 1" deep on dirt fill and sprinkled and tamped.

Redwood is by far the best stock for outdoor use, but locust, red cedar, longleaf yellow pine, and oak also weather well in most climates. Creosoting or other preservative treatment is hardly necessary for redwood. Any other stock should be treated according to local custom for best results. All wood used is 2" rough lumber.

In laying out the stringers, work by the formula in the table on the facing page. The rise and run, *AB* and *BC* in Fig. 1, must first be measured so the number of steps required can be determined. One way is to weight the end of a long board on the upper level and mark the point *C* at the head of the flight. Then raise the outboard



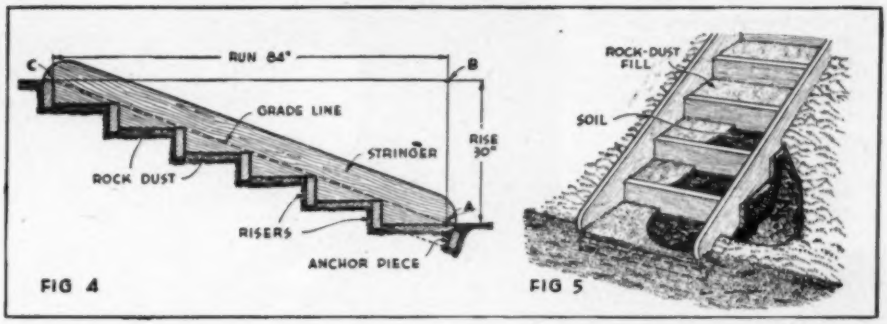


FIG 4 FIG 5

end by hand until a carpenter's level shows it to be horizontal, and with a plumb bob at *A* locate and mark *B*.

Choose for stringers lumber that is free from knots or with knots only in waste wood. Lay out one stringer with the aid of a carpenter's square, as shown in Fig. 2. Saw the ends to shape and saw out the notches between risers and treads with the exception of that at end *A*. Then use this stringer as a template to lay out its mate.

The width of the steps is a matter of choice, but from 30″ to 40″ between stringers will be found practical. Cut the risers and anchor piece to size and spike them to the stringers, as in Fig. 3. It is good practice in building outdoor stairs to have the risers about 1″ higher than called for. Then this extra 1″ can be buried below the surface of the treads, and dirt will not come out from under the edge.

Tack diagonals across the tops of the stringers to keep them from racking out of square. Set the assembly on the previously excavated slope, as indicated in Fig. 4, and level it up. If the ground is very loose, it may be necessary to set 2″ by 4″ or 4″ by 4″ posts outside the stringers at the lower corners. In this event, be sure to spike the posts to the stringers before the postholes are filled. Painting is usually unnecessary, but if it is desired, the assembly should, of course, be painted before it is set in the ground. Since wear will be hard, only the best outdoor paint should be used.

Backfill and tamp in the treads to within 1″ of the top level, and then fill to the top with rock dust (Fig. 5), sprinkle, and tamp. In use, the tread surface will sink somewhat, but it can be built up again easily, and after several such rebuildings little further trouble should be experienced. If bricks are used in the treads, save mortaring until they have finally settled.

BUILDING OUTDOOR STAIRS [*SHIPSHAPE HOME*]

The rule almost universally observed in stair building is that the height of two risers plus the length of one tread is equal to 24″ to 25″. A riser is a vertical strip that separates successive steps, and a tread is a horizontal footboard. To accommodate the longer stride most people use out of doors, outside stairs are generally built with relatively shorter risers and longer treads. As against a standard of 7¾″ for indoor stairs, garden risers vary only about 1″ on either side of the 5½″ mark. If the slope is so steep that risers greater than 6¾″ are required, build ladder-type steps; if treads of more than 16″ will be needed for 4½″ risers, abandon the idea of steps and use a ramp instead.

Assume that you are going to use an equal number of treads and risers for a rise of 30″ and a run of 84″. Rise is always fixed by circumstances, but since it is not necessary to consider headroom, run can be quite variable on outdoor stairs. Dividing 30″ by 5½″, to obtain the number of steps needed, indicates a choice of five or six. Five steps require risers of 6″ and treads of 16 4/5″ to cover the two dimensions. But two of these plus a 16 4/5″ tread would equal 28 4/5″, considerably more than the 24″ to 25″ check measurement. The alternative of six steps calls for 5″ risers and 14″ treads, totaling up to a check measurement of 24″. If the total run were 90″ instead of 84″, treads of 15″ could be used and still conform to the formula.

The following table is given as a means of quickly checking calculations; best results are obtained by keeping to these standards.

Riser	Tread	Twice Riser	Check Measure
4½	15	9	24
4½	16	9	25
4¾	14½	9½	24
4¾	15½	9½	25
5	14	10	24
5	15	10	25
5¼	13½	10½	24
5¼	14½	10½	25
5½	13	11	24
5½	14	11	25
5¾	12½	11½	24
5¾	13½	11½	25
6	12	12	24
6	13	12	25
6¼	11½	12½	24
6¼	12½	12½	25
6½	11	13	24
6½	12	13	25
6¾	10½	13½	24
6¾	11½	13½	25

POPULAR SCIENCE MONTHLY SHOP DATA

Deadly methyl or "wood" alcohol can be ferreted out, if present in a liquid, by adding salicylic acid or aspirin and concentrated sulphuric acid to the solution and standing the container in a beaker of warm water. Any wood alcohol in the solution will be disclosed by the odor of methyl salicylate (synthetic oil of wintergreen).

CHEMISTRY... Household Detective

Simple tests in your own kitchen or home lab give you the low-down on what's in the common articles you use every day.

By
KENNETH M. SWEZEY

HAVE you ever wondered if you were getting the ingredients you paid for in your packaged foods, cosmetics, and medicines? The chances are that most of them, at least, contain just what is claimed, for the Food and Drug Administration of the Federal Government keeps a close check and, besides, no reputable manufacturer would care to risk loss of good will for the sake of unfair profit.

How easy it is to detect substitutes and adulterations can be shown with a few

simple chemical tests. For your "suspect" samples, you can deliberately introduce foreign elements into several familiar household and table items, and then proceed with your chemical detecting.

A little methyl or "wood" alcohol, for instance, may be added to some bay rum, witch hazel, hair tonic, or toilet water for one experiment. Be careful not to use the adulterated liquid for any other purpose, however, for methyl alcohol is a dangerous poison and only ethyl alcohol is present in the legitimate products. Margarine mixed in butter, commercial glucose put in honey, and olive oil diluted with some cheaper oil will do for still other tests. Traces of arsenical and lead insecticides clinging to the skin of fruit can also be discovered if present, but in practice, of course, thorough washing removes these poisons.

One quick, easy method of detecting the presence of methyl alcohol is to plunge a red-hot copper wire into a little of the suspected solution held in a test tube. If a considerable amount of methyl alcohol is present, formaldehyde will be evolved. This gas can be readily recognized by its pungent, irritating odor.

Another method is to convert the methyl alcohol into methyl salicylate, which is synthetic "oil of wintergreen" and has a familiar smell. Into about 5 ml. of the solution stir 5 grams of salicylic acid or a few crushed aspirin tablets (acetylsalicylic acid) and add carefully while stirring 3 ml. of concentrated sulphuric acid. The sulphuric acid absorbs water formed during the reaction and acts as a catalyst. Plug the mouth of the tube loosely with cotton and stand the tube in warm water for 10 or 15 minutes to give the odor a chance to rise.

Methyl alcohol is a potent poison that can cause blindness or death. Be careful when

Butter and margarine act differently when melted in hot milk and then cooled. The former remains emulsified, but margarine separates and collects on the stirrer.

One quick test for distinguishing butter from margarine is to heat a little of each in the bowl of a spoon over a small flame. Butter will foam smoothly and copiously, while . . .

. . . margarine, or butter containing margarine, will foam but little or not at all when subjected to the same test. Instead, the heat will cause it to smoke and sputter in the spoon as hot grease does in a frying pan.

handling it because it may take effect not only through the mouth but also through the nose and skin.

Butter can be distinguished from margarine by the way it reacts when heated. Put a little butter in a spoon, heat it over a small flame, and it will foam smoothly and copiously. Margarine or butter containing it will foam little or not at all and will sputter like hot grease.

The two products also act differently when melted in hot milk and then cooled. Both become somewhat emulsified when stirred into the hot milk, but butter fat remains in that state when the milk is cooled, while margarine separates from the milk and collects as a lump or lumps on the stirrer. A small wooden paddle is best for the test.

If commercial glucose is added to honey, an iodine test will disclose its presence. Dilute a small sample of the mixture with an equal amount of water and add a few drops of a solution of 1 gram of iodine and 3 grams of potassium iodide in 50 ml. of water. When commercial glucose is contained in the mixture, the color will turn red or violet because of erythrodextrins ("red" dextrins) that are almost always found in the artificially manufactured product.

Corn, cottonseed, peanut, and other cheaper oils can be detected in olive oil by a simple color test with nitric acid. Shake up 5 ml. of pure olive oil with an equal volume of concentrated nitric acid in a test tube—but be careful of the acid. After two minutes, allow the mixture to stand. The olive oil may darken, but it will remain yellow. Try the same experiment with olive oil containing another oil, and the mixture will turn brown or red.

Although modern farmers and fruitgrowers use great care in removing the last traces of arsenical and lead insecticides from their products, occasionally a little of these poisonous metals may remain. That is one reason why housewives should wash vegetables and fruit thoroughly before preparing or serving them. At any rate, it makes an interesting project in analysis to test for these poisons. As contamination would be chiefly on the surface, peelings are all that are needed for the tests.

When testing for arsenic, all organic matter that might interfere should first be destroyed by treatment with nitric and sulphuric acids. The fumes given off during this process are poisonous and corrosive, so this preliminary part of the experiment must be performed either outdoors or under a chemical hood. Care should also be taken to prevent spattering of the hot acids on

If commercial glucose is added to honey, it can be detected with a few drops of a solution of iodine and potassium iodide. Commercial glucose contains erythrodextrin, which turns red or violet.

Impurities in olive oil can also be determined by a color test. The oil remains virtually unchanged when shaken up with a little concentrated nitric acid. Cheaper oils become brown or red.

either your bare hands or your clothing.

To about 10 grams of peelings in a porcelain evaporating dish add 5 ml. of concentrated nitric acid and then, carefully, 2 ml. of concentrated sulphuric acid. Heat cautiously to avoid foaming and spattering. Press the peelings under the solution with a glass rod and add nitric acid, a few drops at a time, until all the organic matter is destroyed. This occurs when the solution will not darken further after it has become clear and has given off copious white fumes of sulphur trioxide. Cool and add 8 ml. of water and 3 ml. of a saturated ammonium oxalate solution. Evaporate once more until sulphur trioxide fumes appear again.

The residue may then be tested for arsenic in a homemade Gutzeit generator like the one shown in the photo at right below. This generator consists of a 250-ml. Erlenmeyer flask closed with a one-hole stopper into which the small tip of a conventional drying tube has been pushed. A small wad of glass wool is placed in the constricted end of the drying tube, and the remainder of the tube is loosely filled with crumpled filter paper moistened with a 10-percent solution of lead acetate to absorb hydrogen sulphide fumes that may be generated. Close the upper end of the drying tube with a one-hole stopper fitted with a 5″ or 6″ narrow glass tube. In this put a thin strip of filter paper freshly soaked in a concentrated solution of mercuric chloride and dried.

Poisonous lead can be detected easily by adding a solution of potassium chromate to a solution that contains it. A yellow precipitate is formed.

Place a few small pieces of arsenic-free zinc in the bottom of the flask, add the solution to be tested, and add also 10 ml. of concentrated hydrochloric acid. A few drops of a 10-percent solution of copper chloride will promote the reaction between the acid and zinc. After a half hour, any arsenic present will react with the hydrochloric acid to form the gas arsine. This in turn will discolor the strip of mercuric chloride paper in the upper tube, changing it from a pale yellow to a deep orange, depending on the amount of arsenic present.

A test for lead, either from insecticide residue or from water pipes, is much simpler. Merely add a solution of potassium chromate or dichromate to the solution being tested. The formation of a yellow precipitate of lead chromate will indicate the presence of lead. END

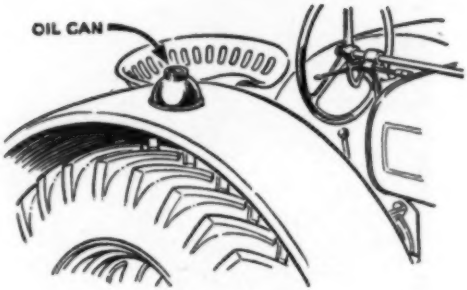
To test fruits and vegetables for arsenic from sprays, first destroy the organic material by heating with nitric and sulphuric acids, as at left. Put the residue in a Gutzeit generator with hydrochloric acid and zinc. The gas arsine, if formed, will discolor the paper in the top tube.

FOR EASIER FARMING

PREFAB FARM BUILDINGS. To reduce the cost, several firms now are producing various farm buildings and structures in prefabricated form. Many already are in use in the West. Here, workmen are seen piecing together a large prefabricated corn crib on an Illinois farm. Looking more like a small airplane hangar than a storage building for grain, it has a capacity of 5,500 bushels of ear corn, plus 2,700 bushels of small grain.

ALARM WARNS OF FIRE. Farmers can obtain quick warning of the outbreak of fire in any of their buildings by using a new electrically operated warning system manufactured by Lord-Taber Company, of Canandaigua, N. Y. The standard equipment includes a control unit for installation in the farm home and 15 thermostats to be placed in various buildings. When fire causes a rise in temperature in any of the thermostat areas, the control unit rings a bell, switches on a red light, and designates the fire location on a dial. In addition to warning of fires, the system may be used to give notice of plant-killing drops in temperature.

NEW BASKET. A rubber-covered egg basket has been developed by the United States Rubber Company to lessen the possibility of breakage during collection of eggs. The rubber is coated on light steel wire. The open construction facilitates cleaning of the basket.



ASH TRAY ON TRACTOR. The possibility of cigarette butts setting a fire in your fields can be lessened by attaching the base of an old oil can to your tractor as an ash tray. A little sand placed in the can and moistened occasionally with a little water will put out any live butts.—Ray Harrison.

New Lightweight Tripod

. . . makes your camera steady and light on its feet

Kodak Eye-Level Tripod is light in weight, quick to set up . . . and built to last for years. It gives rigid, dependable support to movie and still cameras and helps you get pictures free from accidental camera movement. Extends from 22½ inches to 60 inches. $16.75 plus tax.

Kodak Turn-Tilt Tripod Head angles your shots expertly

Easier panning with your movie camera, a versatile accessory support for still shots. New smoothness in performance with a minimum of adjustments. Fits your present tripod or *Kodak Eye-Level Tripod*. $13.25 plus tax.

ENLARGING EASEL speeds making of album prints from miniature negatives

Kodak Miniature Enlarging Easel for 2¼ x 3¼ album prints (with ⅛-inch white margins) from miniature negatives. Makes a rapid succession of record prints from which choice shots may be selected for further enlargement. With its white Tenite base insert, there's no need to use photographic paper while focusing. Two built-in bins hold your papers. It rests on the baseboard of your enlarger. $6 plus tax.

Optipod
$1.50 plus
tax

Kodapod
$2 plus
tax

These clamp-on "tripods" are convenient and steady

Optipod (left) and *Kodapod* (right) are pocket-size and easy to carry—yet give you tripod steadiness. Optipod is felt-lined, fastens to chairs, tables, desks—*Kodapod's* teeth bite firmly into fences, tree branches, etc.

Eastman Kodak Company
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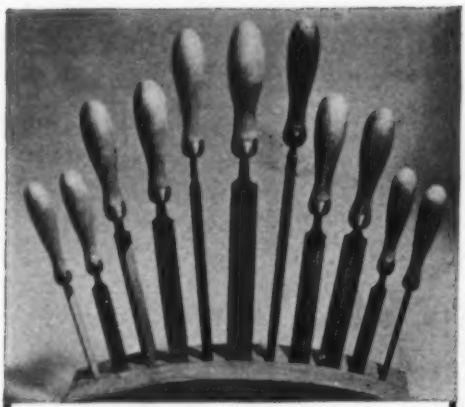
Kodak



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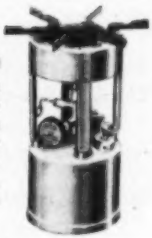

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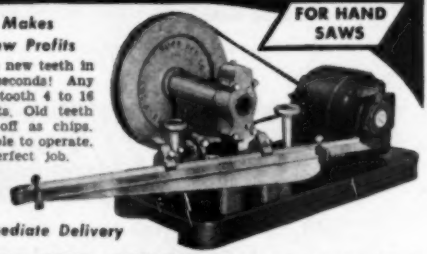

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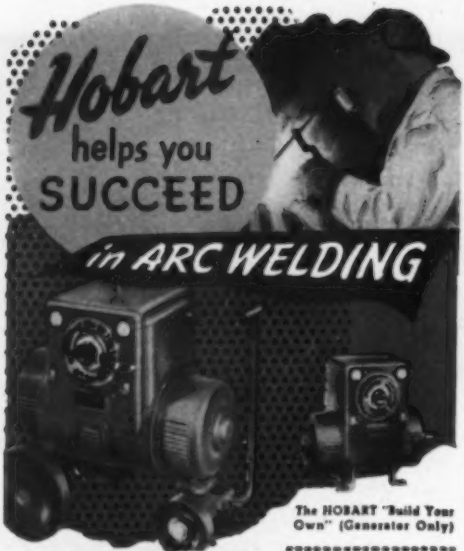

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TOO HOT

If the firing tips on your spark plugs are fused or blistered, the spark plugs are operating too hot and may be causing costly loss of power and harmful spark knock.

HOT PLUG

The longer firing tip of this plug dissipates heat slowly and operates at a relatively high temperature. Stop-and-go driving and slow speeds require this type of plug.

*Even though Auto-Lite Spark Plugs are wide range spark plugs, it is still necessary for best results to select the plug whose heat range will be most suitable for the speed and loads required.

TOO COLD

If the firing tips on your spark plugs show deposits of carbon or are wet with oil, the spark plugs are too cold and may be causing slow, difficult starting and high gas consumption.

COLD PLUG

The shorter firing tip of this spark plug dissipates heat rapidly and operates at a relatively low temperature. High speeds and wide open throttle operation require this type of spark plug.

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"Naturally," I grin, "but is that all you can say for my reline job?"

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"That," I emphasize, "is what we call a 'soft' pedal—it's a major feature of Grizzly Brake Lining! Sure, you get extra long life and hardly ever need an adjustment, but on top of that, you also get smooth, sure stops with that 'soft' pedal. That's what makes Grizzly the safe lining for both men and women. 'Big Foot or 'Little Foot'—driving is easier for both."

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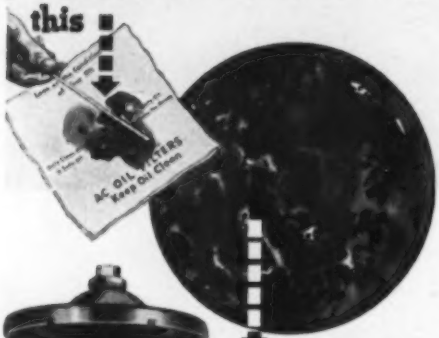

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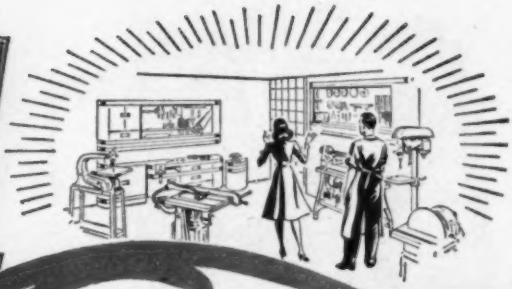

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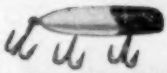

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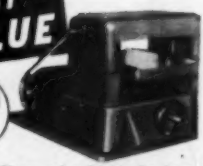

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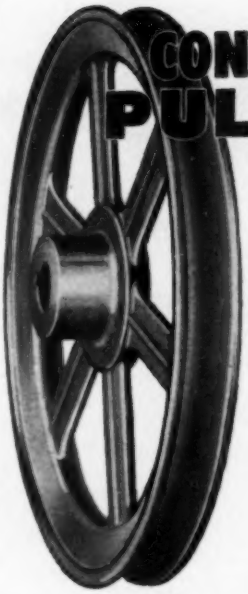

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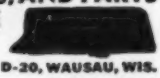

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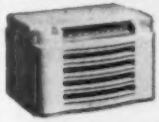

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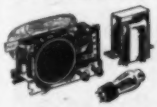

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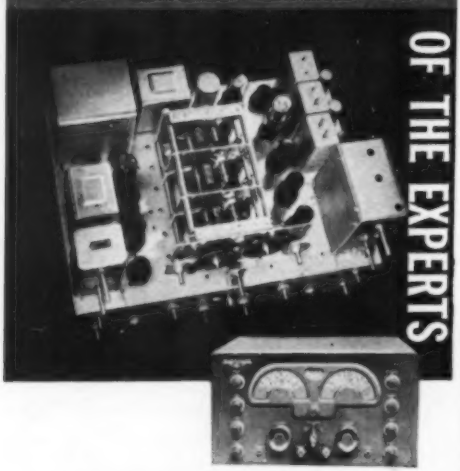

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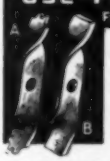

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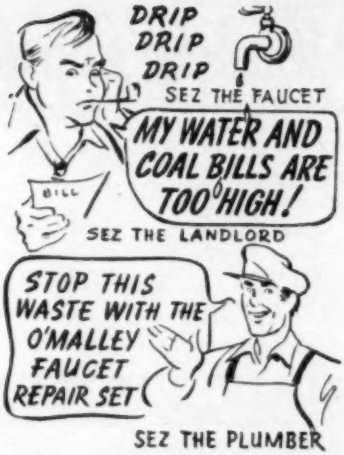

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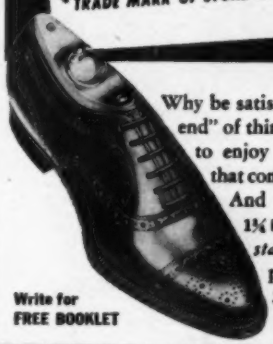

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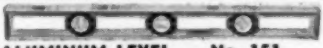

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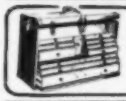

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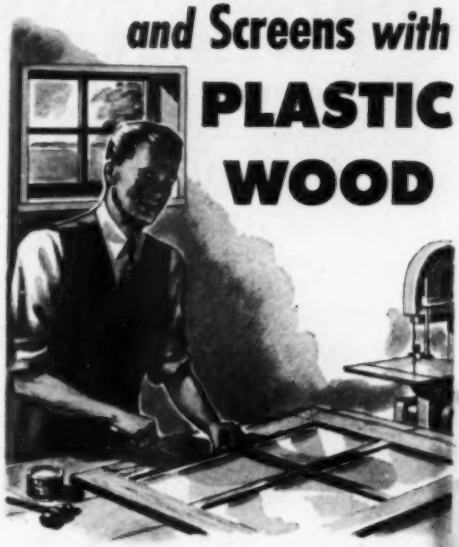

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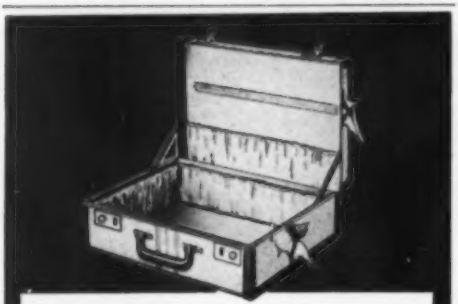

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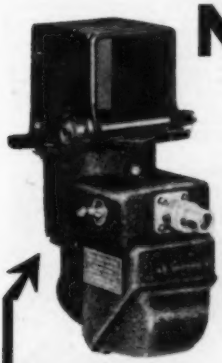

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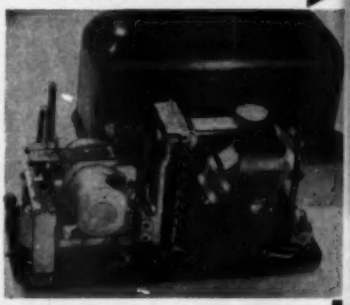

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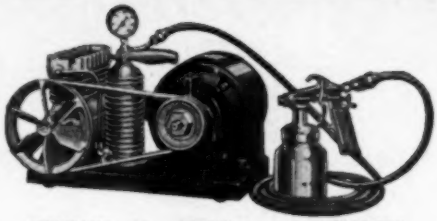

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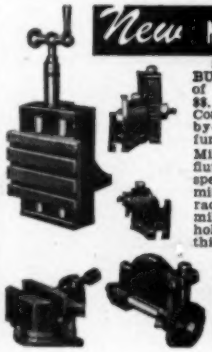

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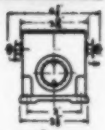

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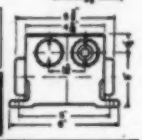

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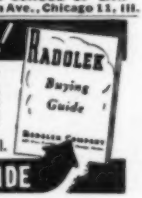

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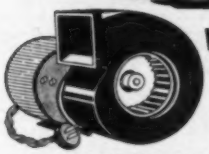

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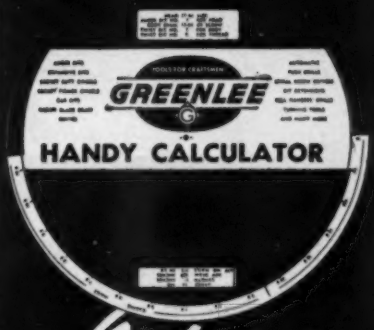

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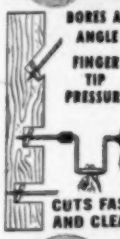

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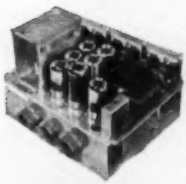

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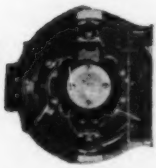

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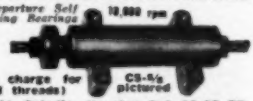

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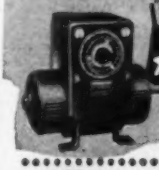

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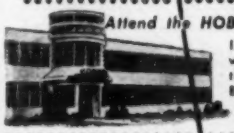

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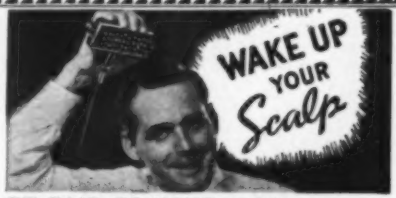

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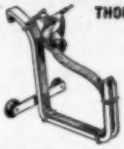

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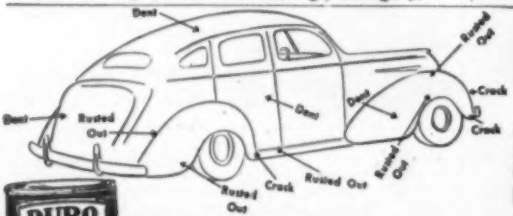

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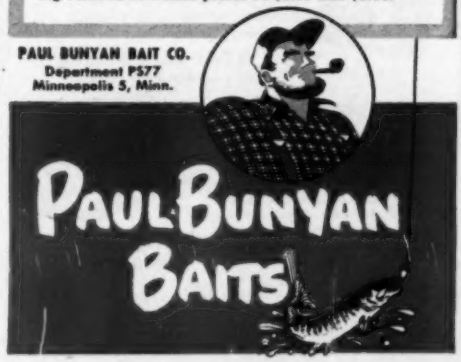

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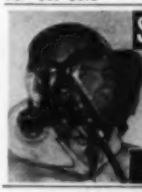

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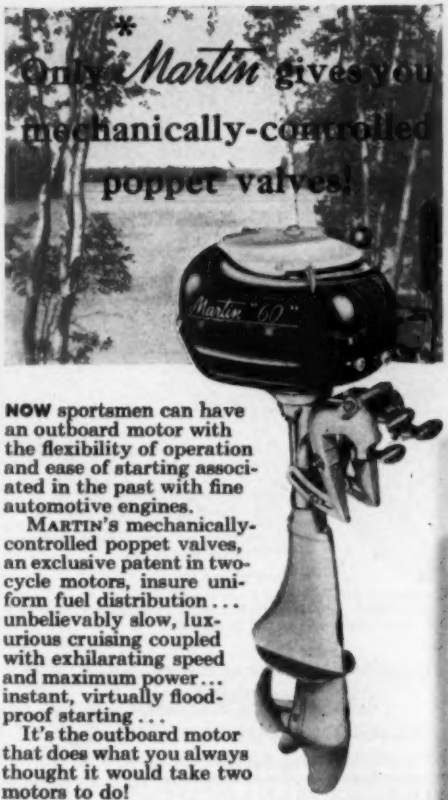

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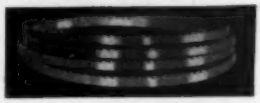

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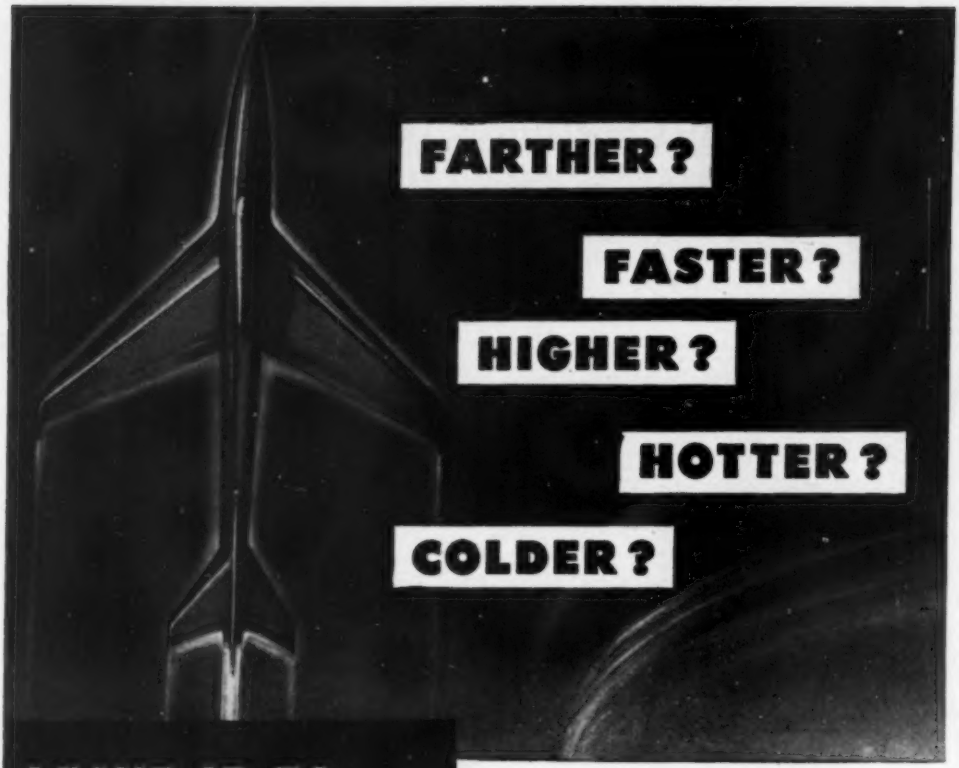

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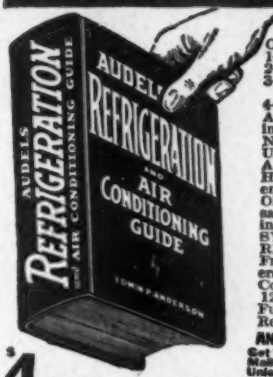

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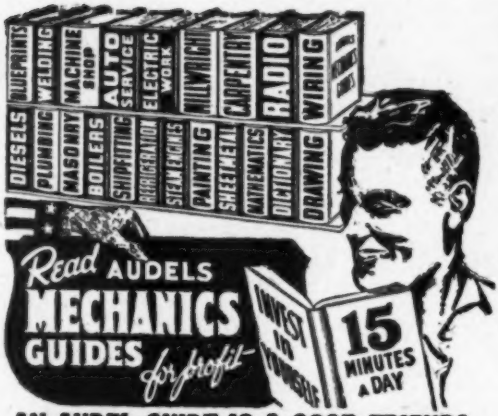

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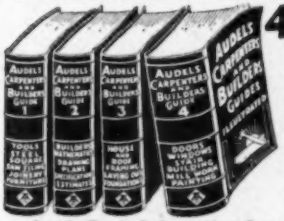

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